THE EFFECT OF A SURROUNDING BOX ON THE SPECTRUM OF SCATTERED X-RAYS

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In the September number of these Proceedings Professor Duane and his collaborators have described experiments in which differences occurred in the ionization spectra obtained from sulphur traversed by X-rays from an X-ray tube with a molybdenum target depending upon the presence of a wooden box surrounding the X-ray tube and the sulphur radiator.[1] The fact that the spectra obtained in the presence of the box were similar to those obtained in this laboratory, whereas those obtained in the absence of the box did not show what we call the "modified lines" suggested to these experimenters that the presence of these lines was dependent upon the presence of the box. If this is true, the origin of these lines must be different from that postulated in the quantum theory of X-ray scattering. It was suggested rather that the modified lines were due to a "tertiary radiation" from the carbon in the wood box.

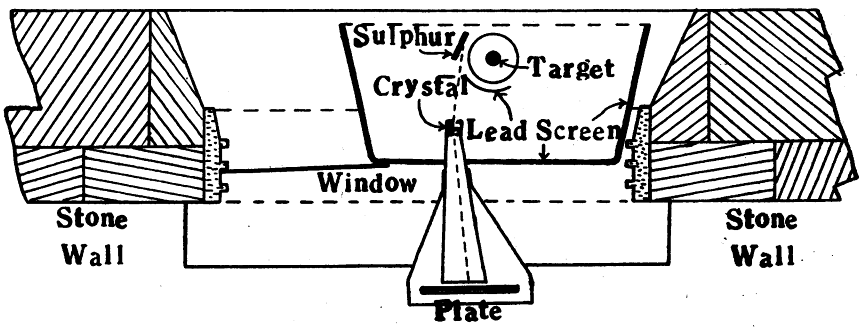

FIGURE 1

The X-ray tube and the sulphur scattering block were placed outside of a window, with a lead screen partially surrounding the X-ray tube to prevent any X-rays from entering the window.

Before our experiment was performed, Y. H. Woo compared the spectra obtained by the ionization method when a lead-lined box surrounded his X-ray tube and radiator with those he previously obtained on using a wood-lined box.[2] The comparison was made for magnesium and aluminium radiators, and new measurements were made on silicon and sulphur radiators. In every case both the modified and unmodified lines appeared with substantially the same intensity as when the wood-lined box was used, and in approximately the positions demanded by the quantum theory.

In order to satisfy ourselves completely, we set up a water cooled molybdenum target X-ray tube and a sulphur radiator outside a third floor window, with no surrounding box, as shown diagrammatically in figure 1. The face of the target pointed upward, so that nearly all of the rays which did not strike the lead screen shielding the window went to the open sky. The spectrum was obtained photographically, using a modified Seeman spectograph. The tube was operated continuously at about 25 m. a. and 47 k. v. peak.

To obtain suitable reference lines on our film, and to be sure that no false lines appeared due to faults in the crystal, the edges of the film were first exposed for 8 hours to the fluorescent rays from a sheet of molybdenum slipped over the face of the sulphur radiator. Thus the $K\alpha$ and β lines of molybdenum were registered, as shown in figure 2. The middle of the film was then exposed for about 170 hours to the secondary rays coming from the sulphur itself. In addition to the unmodified α and β lines, this spectrum shows plainly the modified α line and very faintly the modified β line.

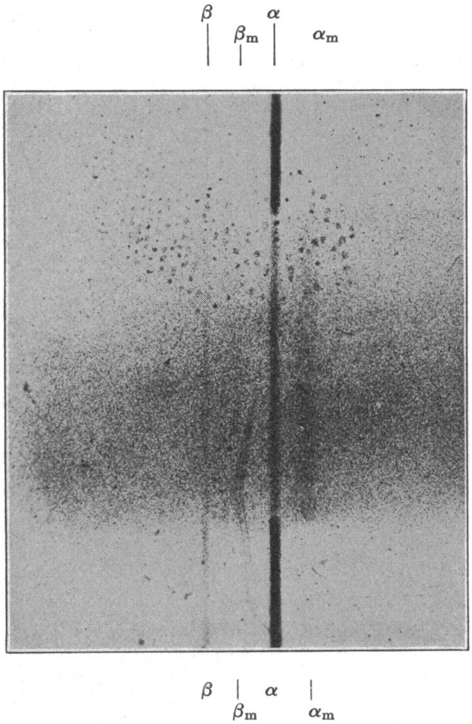

FIGURE 2

Spectrum of X-rays from molybdenum target scattered by sulphur at 118° (middle) compared with spectrum of the fluorescent rays from molybdenum (edges). The presence of the modified as well as the unmodified lines is evident for the scattered rays.

The angle of scattering of the α line was 118 ± 3 degrees, whence according to the quantum formula the wave-length change should be $\delta\lambda = 0.036 \pm 0.001\ A$. Measurements on the $K\alpha$ lines showed $\delta\lambda = 0.037\ A$, which is a satisfactory agreement.

The relative energy in the modified and unmodified lines of this photographic spectrum did not differ much from that shown by Woo's ionization spectra taken with a surrounding box. We are thus unable to find any considerable effect on the character of the spectrum obtained due to the presence of a surrounding box.

[1] Armstrong, A. H., Duane, W., and Stifler, W. W., *Proc. Nat. Acad. Sci.*, **10**, 374 (1924).

Allison, S. K., Clark, G. L., and Duane, W., *Ibid.*, p. 379 (1924).

[2] Woo, Y. H., this number of these PROCEEDINGS.

THE SIGNIFICANCE OF THE DISCOVERY OF X-RAY LAWS IN THE FIELD OF OPTICS

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I. *The Extension of Moseley's Law to the Field of Optics.*—Through our recent stripping of all the valence electrons from one up through seven from the whole group of atoms, sodium, magnesium, aluminum, silicon phosphorus, sulphur and chlorine, and from one up through five from the group, lithium, beryllium, boron, carbon and nitrogen, we have obtained for the first time a long series of light atoms having an identical electronic structure, but a linearly increasing nuclear charge. It is precisely this combination of identity of internal electronic structure among heavy atoms with linearly increasing nuclear charge which is responsible for the existence of the Moseley Law in the X-ray field, and the so-called irregular-doublet law, which flows from it.

Through the recent working out[1] of all the important energy levels (term-values) of the spectra of the stripped atoms of phosphorus (*P V*) and sulphur (*S VI*) and the locating of the first term of the principal series of the stripped atom of chlorine (*Cl VII*) we have been able to complete the experimental proof *that the Moseley Law, with its corollary the irregular-doublet law, holds in the field of optics just as beautifully as in the field of X-rays.*

This work is soon to be reported in detail in the *Physical Review*, but figure 1, gives a very illuminating graphical proof of the foregoing statement. The Moseley Law is shown everywhere in this diagram in the linear progression of our measured term-values with atomic number. The irregular-doublet law is seen in the parallelism between the lines joining the 3*s* terms, the 3*p* terms and the 3*d* terms, or the 4*s*, the 4*p*, the 4*d* and the 4*f* terms.

When it is remembered that these terms are all in the visible or the ultra-violet region explored by ordinary grating methods, it will be seen that the proof is complete that the Moseley Law is quite as much an optical as an X-ray law.

II. *A Possible Interpretation of the Relativity Doublet Law.*—Our fur-