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THE RELATIVE INTENSITIES OF FLUORESCENT AND SCATTERED X-RAYS

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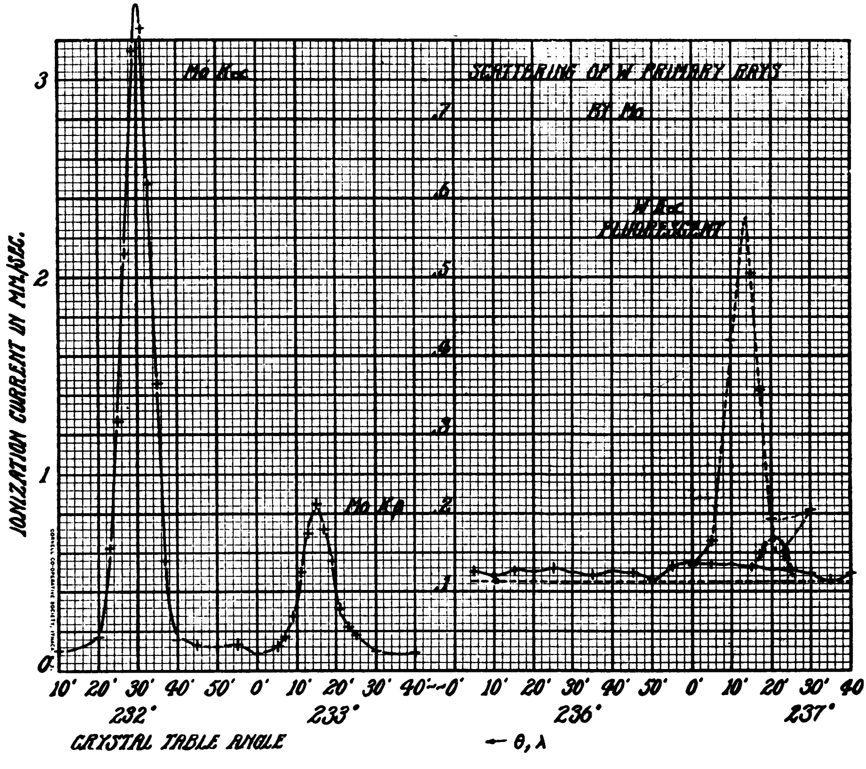
In notes recently published in these Proceedings, we have described experiments on the secondary X-rays from radiators composed of such chemical elements as molybdenum, silver, germanium, etc., due to primary X-rays from a tungsten target. These experiments indicated the presence of scattered tungsten rays and tertiary radiation of almost the same order of intensity as the fluorescent radiation characteristic of the chemical elements composing the secondary radiators. Experiments were reported by Allison and Duane in the January, 1925, number of these Proceedings in which they observed the scattered radiation, including the Compton effect, but only very weak radiation with no sharply marked peaks at the points in the spectra where the tertiary radiation should lie. The experiments described in this note have been performed for the purpose of verifying previous results, particularly with regard to the question as to whether the scattered and tertiary radiation from chemical elements of medium and high atomic weights have really the same order of intensity as the fluorescent radiation.

Figure 1, page 414 of the December, 1923, number of these Proceedings represents the arrangement of the apparatus. Increased lead protection has been provided for the quadrant electrometer and for the ionization chamber where the battery wires enter it. This additional protection reduces the magnitudes of the ionization currents to a considerable extent, presumably due to the cutting off of stray radiation and of radiation scattered in all directions from the crystal.

The full line curve in the figure represents the results of an experiment with a molybdenum secondary radiator and primary radiation from a tungsten target. The peaks marked Mo$K\alpha$ and Mo$K\beta$, corresponding to the fluorescent radiation of molybdenum, are much taller than in the previous experiment and the $K\alpha_1$ and $K\alpha_2$ lines are not separated from each other. This is due to the fact that broader slits were used than in the previous experiments. The scattered radiation, not only near the molybdenum fluorescent peaks, but also at the tungsten *K* series lines, and the tertiary radiation are very weak. In fact the intensity is so small that we cannot measure it with any degree of certainty. The horizontal straight line in the figure represents the ionization current obtained when the crystal has been placed in such a position as not to reflect the rays into the ionization chamber. The height of this line, therefore, represents the influence of stray radiation, etc. The observed currents produced when the crystal is in position to reflect the rays into the ionization chamber are only a very little greater than those represented by this straight line. Hence the scattered and tertiary radiation are of a different order of intensity from the fluorescent.



The curve marked W*K*α represents the *fluorescent K*α doublet from a *tungsten* secondary radiator. It serves to mark the position of the tungsten *K*α lines in the spectrum. Its intensity is very much greater than that due to the *K*α tungsten radiation scattered from *molybdenum*, although experimental conditions such as current, voltage, slit widths, etc., remain the same.

Results similar to the above have been obtained for secondary radiators composed of other chemical elements having atomic weights near that of molybdenum.

When chemical elements of low atomic weight such as carbon were used as secondary radiators we obtained ionization currents of about 0.1 or 0.2 millimeter per second representing the scattered tungsten $K\alpha$ radiation. In other words, the scattered radiation from the light chemical elements has a very much greater intensity than from the heavy, which agrees with previous findings.

The conclusions are that the scattered and tertiary radiation due to tungsten X-rays falling upon chemical elements of atomic weights near that of molybdenum are extremely weak as compared with the fluorescent radiation. They are too weak to be accurately studied with our present apparatus. The large currents in former experiments representing the scattered and tertiary radiation must have been due to some other cause than the radiation coming from the secondary radiator. The general stray radiation will not explain the tungsten peaks observed in the previous experiments and we do not know where they came from.

These very weak spectra will be investigated more thoroughly as soon as the new high tension storage battery has been completed and as soon as a water-cooled tungsten target tube which the General Electric Company kindly furnished us and which was accidentally burnt out has been repaired.

NOTE ON THE QUANTUM THEORY OF THE REFLECTION OF X-RAYS

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In a note published in these PROCEEDINGS for May, 1923, the writer proposed the fundamental principle of a theory of interference and diffraction phenomena based on quantum laws. According to this theory, when a quantum of radiation changes its direction in accordance with the observed phenomena of interference and diffraction, it transfers energy and momentum to the diffracting system. The transfer of momentum, according to the theory, takes place in quanta, the magnitudes of the quanta depending in a particular way upon the characteristics of the diffracting system.