THE COMPTON EFFECT AND TERTIARY X-RADIATION

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This research is a continuation of that by Compton and Woo[1] and was performed to obtain data which bear upon the important question under discussion at the present time, namely, the nature of the change of wave-length due to the scattering.

The exact arrangement of the apparatus was described in the note referred to.[1] The water-cooled molybdenum target tube was operated at about 60 kilovolts peak and 50 milliamperes. In the present work, however, instead of a wood box covered with lead to contain the X-ray tube, the box was completely lined with $^1/_{16}$ inch lead sheet. This was designed to avoid a possible box effect, as described by Allison, Clark and Duane,[2] due to the secondary radiation coming from the carbon and oxygen atoms composing the wooden walls of the box.

The secondary radiators used were rock-salt, magnesium, aluminium, silicon and sulfur. They were all in the form of flat plates. The rays scattered from rock-salt may be regarded characteristic of sodium and chlorine.

The results of the experiments are shown in figure 1. The spectra from sodium, magnesium and aluminium are identical in character with those obtained by Compton and Woo[1] with the X-ray tube in a wood box. The box effect is thus not detected by the present work. The spectra from silicon and sulfur show in each case an unmodified line P occurring at the same position as the fluorescent Mo $K\alpha$ line and a modified line whose peak M is within experimental error at the position predicted by Compton's theory.[3] A detailed examination of the box effect and the confirmation of the wave-length shift in the case of scattering from sulfur by a photographic method is described in the following note by Prof. Compton and Mr. Bearden.

Recently Clark, Duane and Stifler[4] have published accounts of experiments on measurements of the wave-lengths of molybdenum $K\alpha$ rays scattered from ice, rock-salt, aluminium and sulfur. Their results indicate the presence of tertiary radiation whose minimum wave-length is $\lambda\lambda_k/(\lambda_k - \lambda)$, where λ is the wave-length of the incident rays and λ_k is the critical K absorption wave-length of the scattering element.

In figure 1, T marks on each curve the position of the short wave-length limit of the tertiary radiation for the corresponding scattering element. Under the condition of the present experiment the writer found, in every case of the five radiators used, no evidence for the peak of the

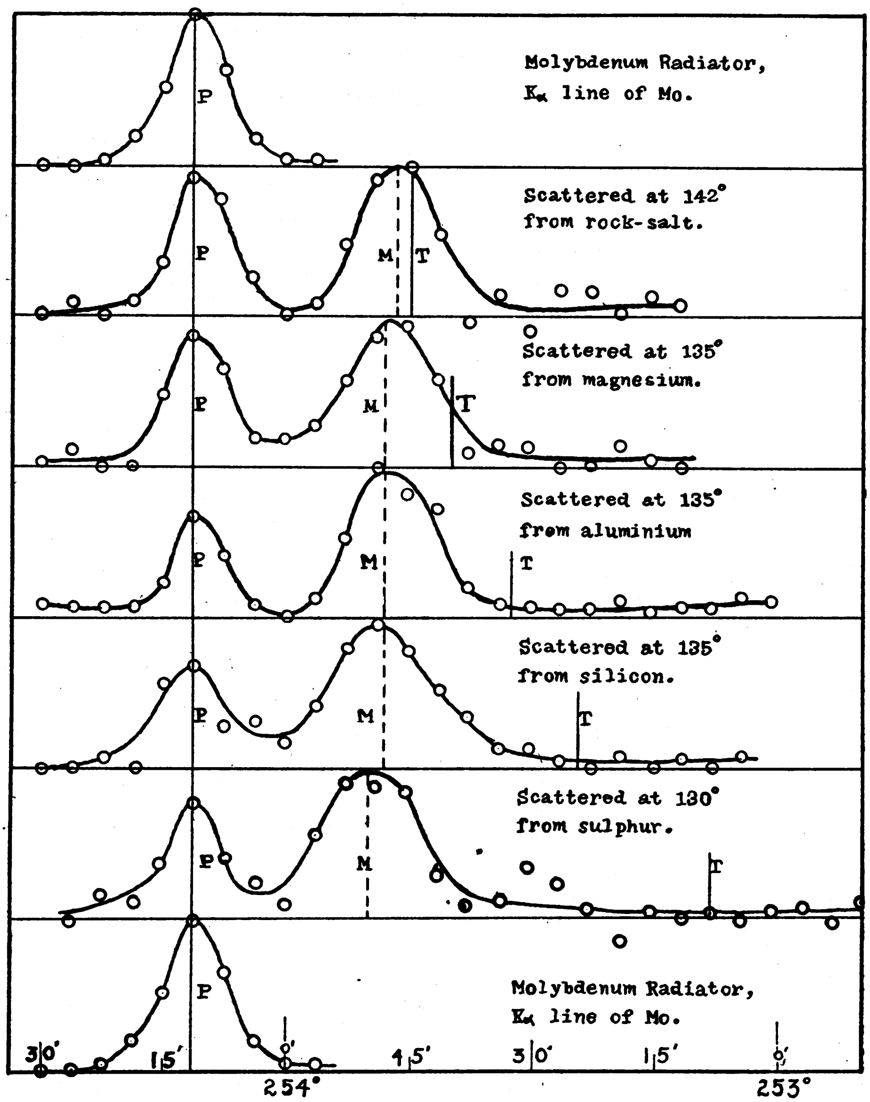

FIGURE 1

Spectra reflected from calcite crystal of the secondary radiation from various elements, traversed by X-rays from a Mo target. *P* marks the position of the primary K_α line, *M* the position of the modified peak calculated from Compton's theory, and *T* the position of the short wave-length limit according to the tertiary ray idea.

tertiary ray as observed by Clark, Duane and Stifler in their experiments.[4] Since the presence of the tertiary ray from sulfur appears to be confirmed by experiments reported more recently,[2] the writer in particular performed ten experiments with sulfur as the secondary radiator (the curve for sulfur in figure 1 represents one of the results). None of these experiments showed the existence of this tertiary peak.

The writer is indebted to Prof. A. H. Compton for his interest in this work.

[1] Compton and Woo, these PROCEEDINGS, **10,** 370 (1924).
[2] Allison, Clark and Duane, these PROCEEDINGS, **10,** 370 (1914).
[3] A. H. Compton, *Physic. Rev.*, **21,** 483 (1923).
[4] Clark, Duane and Stifler, these PROCEEDINGS, **10,** 148 (1924).

THE AGE OF THE STARS

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It is well-known that the supply of energy made available by the gravitational contraction of the material of a star is insufficient, in view of the Stefan law of total radiation, to allow the time-life of a star to be more than a small fraction of the age demanded by geological considerations. Discussions of the problem of maintenance of stellar energy have been given by Shapley[1] and Russell.[2] The former discusses an hypothesis of asymmetrical radiation flow in which the rate of radiation to empty space is much less than the radiation toward other matter. Shapley also considers the destruction of mass as a possible source of stellar energy. He concludes that "... it now appears that the disagreement between the long and short time scales must be decided in favor of an exceedingly prolonged history for sidereal systems, permitting a relatively slow evolutionary development for stars and planets." Russell's paper is a very general sketch of the main outlines of the problem and is concerned mainly with the conditions under which a nuclear "unknown" source of energy comes into action.

In this paper, it is shown that the relativistic relation between energy and mass leads directly to a means of estimating the age of the stars, the method being independent of the atomic processes whereby mass as "matter" is changed into mass as "radiant energy." This relation,

$$\Delta E = c^2 \Delta m \tag{1}$$

in which E is the energy of the system in ergs, c the fundamental constant