LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

An Interpretation of the Effect of Piezoelectric Oscillations on the Intensity of X-ray Reflections from Quartz

G. W. Fox and P. H. Carr[1] have reported an increase in intensity and number of spots on a Laue pattern through quartz, due to oscillation of the crystal slip as part of a piezoelectric oscillator. Radiation was used from a tungsten target running at 95 kv. As this voltage is considerably above the excitation voltage of the K series of tungsten (69.3 kv), the radiation which they used contained the K lines of tungsten in addition to the continuous spectrum. Any single wave-length in an x-ray beam will not in general fulfill the reflection conditions for any of the planes in a crystal if the crystal specimen is stationary. However, by a slight rocking motion of the crystal, various planes will be brought into the proper orientation for reflection of a given wave-length. The wave-length of the $K\alpha$ line of tungsten is so short (0.211A) that a very slight rocking of the crystal would allow a large number of high order reflections to take place. In the above experiment by G. W. Fox and P. H. Carr the slight rocking of the crystal by piezoelectric oscillation was sufficient to allow reflection of the strong $K\alpha$ or $K\beta$ line of tungsten by a number of the crystal planes. That only a very faint Laue pattern is produced by the non-oscillating crystal is due to the fact that the crystal thickness and primary beam intensity make the usual Laue pattern too weak to be seen. Monochromatic patterns of this sort somewhat similar in appearance to the usual Laue picture have been made by W. L. Bragg.[2]

There are three simple ways to check the correctness of this interpretation. (1) Lower the tube voltage to less than 69 kv so that the K lines will not be excited. The effect should disappear. (2) With the tube at 95 kv rock the crystal slip slightly mechanically. The same effect should be produced as by piezoelectric oscillation. (3) Make a Laue gnomonic projection of the pattern and calculate the $n\lambda$ values in the usual way. Most of these values should be multiples of the wave-lengths of $K\alpha$ or $K\beta$ for tungsten.

B. E. Warren
Massachusetts Institute of Technology,
July 6, 1931.

[1] G. W. Fox and P. H. Carr, Phys. Rev. **37,** 1622 (1931).

[2] W. L. Bragg, Nature **124,** 125 (1929).

Corrected Relative Intensities of the X-ray Lines in the Tantalum L Series

In a paper which appears elsewhere in this number of the Physical Review, Allison and Andrew report, for the three stronger lines of the L series of tungsten (74), preliminary measurements of relative intensities which are widely different from those reported for the same lines of the L series of tantalum (73).[1] The error mentioned by Allison and Andrew in their footnote 11 is due to the use of an ionization chamber of faulty design in the tantalum measurements. This chamber was made of a piece of glass tubing 33 cm long. A cylinder of nickel gauze, 28 cm long, was placed just inside the inner wall of this tube and was kept at a potential of 170 volts. The end of the chamber nearest the crystal was closed with a brass cap with a slit in it, a flange on this cap extending a little distance into the tube. This cap was erroniously grounded. Thus, the ions formed by the x-ray

[1] Hicks, Phys. Rev. **36,** 1273 (1930).

beam immediately upon entering the chamber were repelled to the metal cap, instead of to the collecting rod which was placed inside the nickel gauze. The x-ray beam, then, travelled through an absorbing layer of methyl iodide about 5 cm long before ions were produced that reached the collecting rod. The length of this absorbing layer can be estimated only very roughly. On the assumption that the path of absorption was actually 5 cm long, the corrections in Table I have been computed, using the absorption coefficients for methyl iodide given by Allison and Andrew and data to be found in the paper on the tantalum L series intensities.

TABLE I. *Corrected relative intensities of lines in the tantalum L spectrum.*

Line	Correction Factor	Rel. Int. 30.6 kv	Rel. Int. at High voltage
l	2.4	3.6	3.6
α_2	1.1	11.	11.
α_1	1.0	100.	100.
η	.85	1.1	1.2
β_4	.58	5.4	6.4
β_1	.55	51.	57.
β_3	.52	6.8	7.4
β_2	.49	20.	20.
β_7	.47	.4	.4
$\beta_5+\beta_{10}$	.46	.5	(.5)
β_9	.46	.4	(.4)
γ_5	.38	.5	.6
γ_1	.35	10.	11.
γ_6	.34	.2	.2
γ_2	.33	1.7	2.0
γ_3	.32	2.3	2.7
γ_4	.30	.7	.8

The writer feels that these corrections are not any more than approximately ten percent accurate for the lines of wide wave-length separation, since the thickness of the absorbing layer of methyl iodide can be estimated only roughly. Nevertheless, application of these corrections bring the measurements on tantalum into much closer agreement with the results of Jönsson[2] than previously reported. They are also in fair agreement with the results of Allison and Andrew when the intensities are compared at corresponding voltages, as the relative intensities of the tantalum α_1, β_1, γ_1, lines are, as corrected and at 20 kv, 100:45:8.7 in comparison with 100:43.7:9.1 as reported for the corresponding lines of tungsten.

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July 2, 1931.

[2] Jönsson, Zeits. f. Physik **36**, 426 (1926).

X-ray Reflections from Oscillating Crystals

A few days ago B. Warren addressed to these columns a letter offering an explanation of the striking results of Fox and Carr,[1] who found that the Laue pattern of a quartz oscillator strengthened when the crystal was set into oscillation. Warren's explanation was so straightforward and plausible that the present writer decided to drop an alternative suggestion in the process of development even before the crucial tests proposed by Warren had been attempted.

Further discussion, however, threw some doubts upon the applicability of Warren's idea and so after indicating these I shall mention the alternative explanation which is easily capable of accounting for the facts, and which lends great interest to the experiments of Fox and Carr. The basis for Warren's interpretation is that there are probably a few strong lines of short wave-length in the incident radiation and that there is some jiggling of the crystal in the act of oscillating. An angle displacement introduced by the jiggle of less than one degree would bring many planes into the reflecting angle for such short wave-lengths and one might expect many spots not on the picture of a quiet crystal. Calculation shows however that since the reflection maxima have a width of several seconds, there should have been occasional strong spots from the quiet crystal. The experimenters make no mention of such spots. Moreover, the incident radiation filled an angle of almost two degrees. Under such conditions, rocking the crystal through less than one degree would have practically no effect on the total intensity of the Laue spots. True, a fraction of the spots might be enhanced but an equal number would be weakened. The tests proposed by Warren are surely still worth trying, but on the other hand a new suggestion is now in order.

My notion is to connect the phenomenon

[1] G. W. Fox and P. H. Carr, Phys. Rev. **37**, 1622 (1930).