MODIFIED REFLECTION OF X-RAYS BY CRYSTALS: CALCITE

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1. *Introduction*

In a note under the title 'A New X-Ray Effect', Raman and Nilakantan[1] have recently described the essential features of a new type of X-Ray reflection which may be looked upon as the analogue in X-ray optics of the now familiar Raman scattering by crystals. In a series of subsequent papers,[2] the results of a detailed study in diamond and sodium nitrate have been described and discussed by these authors.* Raman and Nagendra Nath[3] have also outlined a formal theory of this phenomenon and derived the more important laws which govern the same.

The authors are now engaged in a study of this effect and the detailed measurements which are planned are still in progress. Nevertheless, it is thought desirable to publish here an account of the preliminary results obtained with calcite in view of the novelty of the phenomenon.

2. *Experimental Details and Results*

A plate of calcite with its faces parallel to a cleavage plane (211) has been used in this investigation. The source of X-rays is a Shearer tube with a copper anticathode. The Cu K_α and Cu K_β rays along with a certain amount of white radiation are present in the incident beam. The crystal is so mounted that the incident beam falls on the (211) planes, which have a spacing of 3·029 A.U., at approximately the correct Bragg angle for Cu K_α radiation. A series of five pictures reproduced in Fig. 1 are obtained for angles of incidence which deviate slightly and progressively from this setting. On account of the heavy absorption of X-rays in the fairly thick plate of calcite chosen, the investigation could not be pushed to angles of incidence which differ widely from the correct Bragg angle. Fig. 1*a* refers to the initial setting. In Figs. 1*b*, *c*, *d* and *e*, the angles of incidence are 1°, 2°, 2½° and 3°

* Siegel and Zachariasen (*Phys. Rev.*, 1940, **57**, 795) have reported the appearance of subsidiary diffraction maxima in X-ray scattering which presumably have a similar origin. Their investigations have, however, been confined to the very close neighbourhood of the correct Bragg setting.

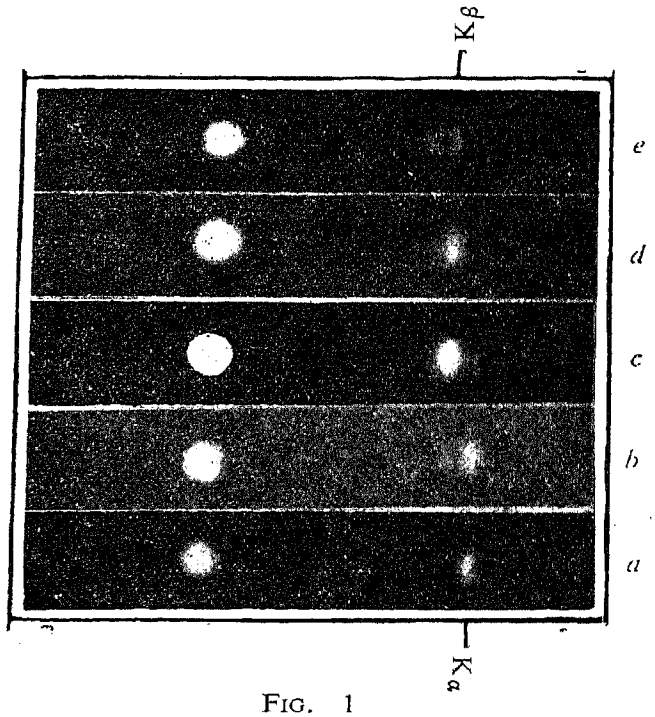

FIG. 1

Showing modified reflections due to Cu K_α and Cu K_β radiations from (211) planes of calcite

respectively less than the initial setting. The modified spots due to K_α are clearly seen in Figs. 1*a*, *b* and *c* and those due to K_β are clearly seen in Figs. 1*b*, *c*, *d* and *e* while the Laue spot due to the (211) planes, which apparently falls on the top of the K_α modified spot in Fig. 1*b* and on the top of the K_β modified spot in Fig. 1*c*, may be seen clearly separated in Figs. 1*d* and *e*. Results of measurement and calculation are given below in Table I.

TABLE I

Modified Reflections from (211) *Planes of Calcite*

Setting	Spot distance from centre	$\theta + \phi$	Spacing
Fig. 1 *a* ..	2·67 α	29° 30′	3·018
,, 1 *b* ..	2·67 α	29° 30′	3·018
,, 1 *b* ..	2·38 β	26° 46′	3·002
,, 1 *c* ..	2·66 α	29° 24′	3·029
,, 1 *c* ..	2·40 β	26° 57′	2·983
,, 1 *d* ..	2·40 β	26° 57′	2·983
,, 1 *e* ..	2·38 β	26° 46′	3·002

α and β denote that the spots arise from Cu K_α and Cu K_β respectively. The plate distance employed is 4·72 cms. and $\theta + \phi$ stands for the total deviation produced in the X-ray beam on reflection. The spacing, calculated with the help of the symmetrical formula $2d \sin \frac{1}{2}(\theta + \phi) = \lambda$, is given in column 4 in each case.

3. *Discussion of Results*

The standard value of 3·029 A.U. for the (211) spacing of calcite may be compared with the figures given in column 4 of Table I. Results based on the symmetrical formula alone have been given in this table. Raman and Nilakantan have suggested an unsymmetrical formula also which was found by them to hold good in the case of diamond. Application of this to calcite leads to more or less the same spacing values as are given in column 4 of Table I and is not therefore separately considered here. The range of investigation has, in fact, been so narrow that the experimental results obtained cannot decide in favour of one or other of these alternative formulæ. The rapid fall in the intensity of the Laue spot as well as the modified spots, as we move away from the correct Bragg setting, may be attributed to the relatively small amount of white radiation that is present in the incident beam and the large absorbing power of calcite.

4. *Summary*

Modified X-ray reflections, due to Cu K_α and Cu K_β radiations from the (211) planes of calcite, have been recorded. Their positions are measured and the results lead to a spacing which remains nearly constant for all the settings studied. This agrees well with the standard value, namely 3·029 A.U.

REFERENCES

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2. ———— .. *Proc. Ind. Acad. Sci.*, 1940, **11**, 379, 389 and 398.
3. Raman, C. V., and Nagendra Nath, N. S. — *Ibid.*, 1940, **12**, 83.

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