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Relation between the Width of an X-Ray Line and the Resolving Power of the Double-Crystal Spectrometer

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The widths of some $K\alpha_1$ lines were measured in a double-crystal spectrometer in the (1,+1) position. It was found that the difference between the experimental width of the line and the width of the rocking curve had a constant value when perfect crystal gratings were used.

THE relation between the width of an x-ray emission line and the resolving power of the double-crystal spectrometer has been investigated in the wavelength range 2285 x-units (the Cr $K\alpha_1$ line) to 708 x-units (the Mo $K\alpha_1$ line). The crystal gratings used were different atomic planes in quartz and calcite. It has been shown previously that the reflection properties of these crystals are in good agreement with the predictions from the dynamical theory for x-ray diffraction, so that these crystals can be considered to have a nearly perfect structure. In this investigation the shape of the rocking curve was calculated for the crystal gratings under consideration and compared with the experimental curves. Only such crystal specimens where the two curves showed a satisfactory agreement were used, so that all these quartz and calcite crystals proved to be perfect. Owing to the dynamical theory the diffraction pattern of position (1,+1) is identical with that of position (1,−1) (the latter being the rocking curve) when the absorption is negligible. When the absorption increases, the pattern in position (1,+1) becomes asymmetric, but in the wavelength range used its width at half-maximum intensity is everywhere nearly the same as that of the rocking curve. The difference in shape between the curves is also slight. Hence, the width of the rocking curve can be used as a measure of the resolving power of the double-crystal spectrometer, for which reason it has been determined for every emission line examined. It was also possible to use crystal gratings with small spacings and high resolving power, since the measurements were carried out on strong spectral lines, mostly $K\alpha_1$ lines.

The results appear in Fig. 1. The width W_R of the rocking curve, the experimental line width W_{exp}, and the true width W_T of the line were found to satisfy the relation

$$W_{\text{exp}} = W_T + W_R.$$

If we assume that both the emission line and the rocking curve have the classical line shape, this relation can be derived theoretically.

It should be mentioned that line-width determinations carried out with slightly imperfect crystals gave rise to large deviations from the results in Fig. 1, when the crystal gratings had low resolving power. (Such crystal gratings are for instance calcite 211, quartz $10\bar{1}1$, and quartz $10\bar{1}0$.) When the resolving power was high, small imperfections were unimportant. This can be seen from the measurements with topaz 400 which

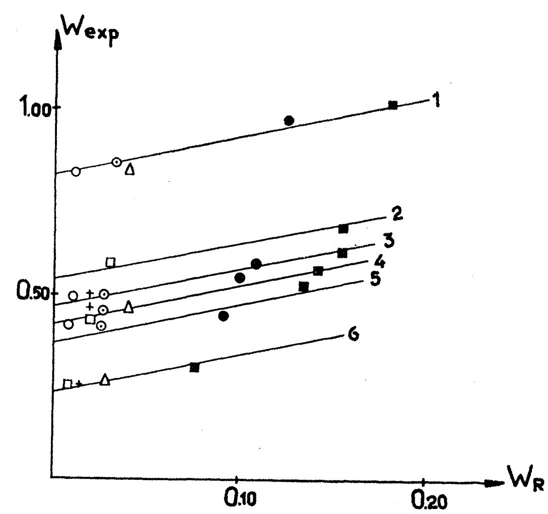

FIG. 1. The full widths W_{exp} of some $K\alpha_1$ lines as functions of the full widths W_R of the rocking curves. The lines are: Fe (1), Co (2), Ni (3), Cu (4), Zn (5), and Mo (6). The following crystal gratings were used: ■ calcite $2\bar{1}1$, □ calcite $42\bar{2}$, ● quartz $10\bar{1}0$, ⊙ quartz $20\bar{2}0$, ○ quartz $30\bar{3}0$, △ quartz $11\bar{2}0$, + topaz 400. The experimental values obtained with Cr $K\alpha_1$ are not shown in the figure, because they fall along curve (1).

are also given in the diagram. This crystal has a mosaic structure, but on account of the high dispersion the mosaic broadening has hardly any influence on the line width.

The above results indicate that the values of x-ray line widths and x-ray energy levels accepted at present are, as a rule, too great.

An extensive report will be published later in *Arkiv för Fysik.*