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The measurement of the crystal-to-source distance.

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A simple method is suggested for measuring the crystal-to-source distance, r_0, which is needed for applying Phillips's correction.

It is well known that owing to the divergence of the incident X-ray beam, the reflexion spots become elongated on one half and contracted on the other half of an upper level Weissenberg photograph. Phillips (1954) deduced the expression describing the variation of spot-length of elongated reflexions and later suggested a method (Phillips, 1956) of correcting the intensities. When applying this method in practice, one needs the value r_0, the crystal-to-source distance. Phillips (1956) assumed the 'source' to be coincident with the collimator pin hole and thus took the distance between the collimator pinhole and the crystal as r_0. This distance in most goniometers is 75 mm.

Recently Lonsdale (1964) emphasized the importance of using the correct value of r_0 and recommended the use of its measured value in computing the correction factor.

A simple method for the measurement of r_0 is suggested in this communication and it is pointed out that the correction factor is not very sensitive to errors in the value of r_0.

Measurement of r_0

Lonsdale (1964) suggested that r_0 can be measured by 'taking photographs on the same film in (stationary) cameras of different radii, but with the same collimator system; or by measuring the variation of spot size in a specially designed film pack'. In the present method the variation $\mathfrak{L}$, the reflexion-spot-size, with ζ on a normal-beam oscillation photograph, is used to compute the value of r_0.

For a normal-beam method, the length of the reflexion spot on a stationary camera of radius r_1 is given by

$$\mathfrak{L}=2\alpha_n[r_1(1-\zeta^2)^{-3/2}+r_0]\,. \qquad (1)$$

$2\alpha_n$ is the effective divergence (Singh, 1966) of the beam. If $\mathfrak{L}$ for two different values of ζ can be measured, then the values of $2\alpha_n$ and r_0 can be calculated. However, the situation is complicated by the fact that the spot size varies with the exposure time. To take into account this effect, let the measured spot length $\mathfrak{L}'$ be related to the correct length $\mathfrak{L}$ by $\mathfrak{L}=p(t)\,\mathfrak{L}'$ where $p(t)$ is a factor which depends on the exposure time. If one deals with reflexion spots of nearly equal optical density $p(t)$ is approximately a constant and equation (1) may be rewritten in the form

$$\frac{p(t)}{2\alpha_n r_1}\,\mathfrak{L}'=(1-\zeta^2)^{-3/2}+(r_0/r_1)\,. \qquad [(2)$$

Reflexion spots of nearly equal optical density were chosen in different layers of a normal-beam oscillation photograph. The spot lengths were measured by a travelling microscope (×2·5) and equation (2) was solved for r_0/r_1 by the method of least squares. The results of the measurement made on three different crystals are given in Table 1.

Table 1. *Results of measurements of* r_0

Crystal	ADP	Arsanilic acid	*o*-Tolidine
r_0(mm)	39 ± 2·0	46·0 ± 2·0	42·0 ± 2·0
Mean r_0	42 mm		

The value of r_0 obtained by this method seems to vary slightly from crystal to crystal. This variation may be due to the varying degree of perfection of the crystal specimens and to the departure of the actual case from the simple model assumed in the derivation of equation (1) (Phillips, 1954).

In order to see the dependence of the correction factor $W=(\mathfrak{L}+\Delta\mathfrak{L})/\mathfrak{L}$ on the value of r_0, W has been calculated from equation (9) of Lonsdale (1964), using (*a*) $r_0=75$ mm and (*b*) $r_0=50$ mm. It is seen from Table 2 that, taking the correct value of r_0 as 50 mm, change in the value of r_0 from 50 mm to 75 mm introduces an error of the order of ten per cent for low angle reflexions and nearly five per cent for the middle range reflexions.

Thus we see that the correction factor, W, is not very sensitive to the errors in the value of r_0; therefore a mean value of r_0 obtained by the present method can be taken as constant for a given collimator.

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Table 2. *The calculated values of W with* (*a*) $r_0=75$ *and* (*b*) $r_0=50$ mm *for various* sin θ *values*

$\upsilon=15°$ and $r_1=28·64$ mm

sin θ	0·30	0·35	0·40	0·45	0·50	0·60	0·70	0·80	0·90
$W(a)$	1·445	1·281	1·213	1·172	1·143	1·105	1·078	1·056	1·036
$W(b)$	1·585	1·370	1·280	1·226	1·188	1·138	1·102	1·074	1·047
$\frac{W(a)-W(b)}{W(b)}\times 100$	8·8	6·5	5·2	4·4	3·8	3·1	2·2	1·7	1·1