The device shows the following properties:

(1) A gain in intensity by a factor 3–5 can be achieved relative to the usual slit system producing a similar beam.

(2) The intensity and the angular distribution of the emerging beam are nearly uniform over its whole width.

(3) Adjustment in the X-ray beam can readily be done by hand, using a fluorescent screen.

(4) The halo close to the primary beam, which is caused by the uneveness of the surfaces, is little extended.

Using glass and Cu $K\alpha$ or Fe $K\alpha$, this scattering is limited to 12′ from the central ray, so spacings up to 350–400 A. may be measured with this collimator. The scattering appears to be nearly independent of the width of the slit, and therefore of the divergence of the emerging beam. It seems possible further to reduce this scattering by several minutes of arc by improving the quality of the polish of the mirrors.

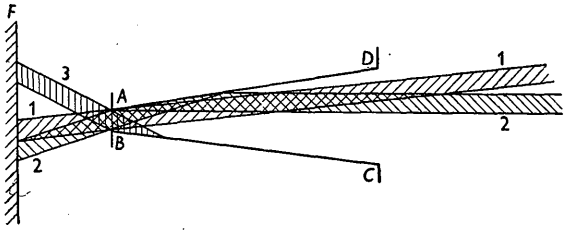


Fig. 1. Principle of the collimator. Three beams from the focus of the X-ray tube enter the narrow aperture AB of the collimator. The angle between the polished surfaces AD and BC is β; the critical glancing angle is η. Beam 1 passes unreflected. Beam 2 is reflected once. Beam 3 is absorbed because $\frac{1}{2}\alpha_0 > \eta + \frac{1}{2}\beta$.

(5) The collimator acts more or less as a monochromator. The critical angle being roughly proportional to the wave-length, the effective width of the incident beam and thus the intensity of the emerging beam are proportional to the wave-length, neglecting terms in β.

The construction of the collimator is easy (Fig. 2). Two glass bars (II and III) of the required length are assembled with their polished surfaces facing each other, a thin wire or foil of suitable thickness is placed between the ends of the bars, and these plates are cemented between two plates I and IV. After removal of the spacing pieces the apparatus is ready.

It is also possible to construct a (square) pinhole collimator by putting four polished plates together in the manner sketched in Fig. 3. The gain in intensity may in this case amount to a factor 10–30 over the usual pinhole system.

For the mirrors a material should be used showing a rather small critical angle $\eta_i \leqslant 15'$. With larger η the reflexion coefficient is not 100% below η, and the reflexion curve shows a long tail. Provided the reflexion coefficient is 100% below η, calculation shows it to be possible to obtain, by a suitable choice of dimensions, an emerging beam of a certain intensity and divergence independent of η.

We have constructed a slit wedge of glass 120 mm. long, 9 μ wide at the narrow side and 140 μ at the other end. $\eta = 14{\cdot}5'$. α_e, the divergence of the emerging beam, is 5·8′ (Cu K).

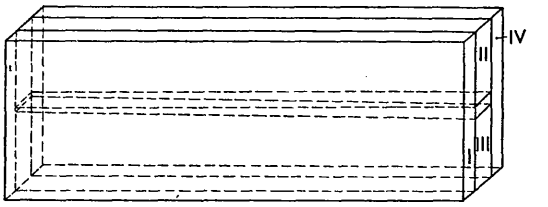


Fig. 2. Construction of a slit collimator.

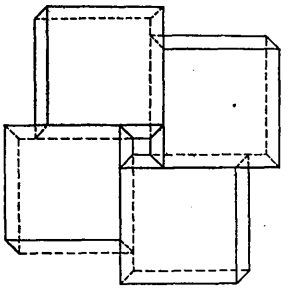


Fig. 3. Construction of a square pinhole collimator showing front view on the wide aperture.

With an X-ray tube of 1·2 × 1·2 mm.² apparent focal spot, run with 30 mA. at 30 kV., we made an exposure of wet collagen, 1 mm. thick. With a specimen–film distance of 200 mm. an exposure of 20 hr. was required for a good diagram containing the orders 2–25 of the long spacing of 660 A.

Calculation, verified by a few preliminary experiments, shows that a wedge 120 mm. long with apertures of 10 and 100 μ shows the same α_e of 6′. On account of the narrower beam, the film distance may be shortened to 140–150 mm. In this case exposures of 6–8 hr. only are required.

A paper discussing the geometrical relations, calculations on the intensity of the beam and some experiments on the nature of the scattering close to the primary beam will be published shortly.

Acta Cryst. (1949). **2**, 338

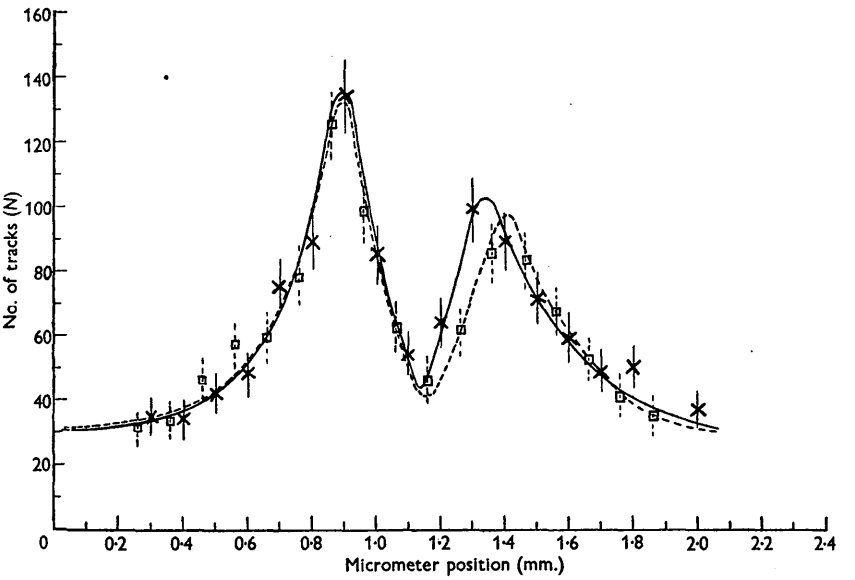
A method for the comparison of the intensities of X-ray reflexions using nuclear research emulsions.

By H. J. Wellard. *H. H. Wills Physical Laboratory, University of Bristol, England*

(*Received* 22 *June* 1949)

If the tracks produced by X-rays in a suitable electron-sensitive emulsion are counted, then the number of tracks, N, gives a measure of the intensity of radiation incident upon the area considered, subject to a statistical error of $\pm(\sqrt{N}/N) \times 100\%$, i.e. $\pm 3\%$ if $N = 1000$ or $\pm 1\%$ if $N = 10^4$. In order to test the method, Ilford G.5 emulsion 30 μ thick coated on to 0·005 in. cellulose acetate base was exposed in a circular camera to silver $K\alpha$ radiation

reflected from a single crystal, and a plot of N against distance was made across the centre of an $\alpha_1\alpha_2$ doublet occurring on the first layer line above and below the centre line of the film. These may be assumed to have the same shape and to be of equal intensity. The diagram shows the experimental curves to be in agreement within the statistical expectation, and indicates that this and similar emulsions are suitable for the comparison of X-ray intensities.



Crosses and full lines: doublet 1. Squares and broken lines: doublet 2. Vertical lines indicate expected statistical error ($=\sqrt{N}$).

The advantage of this over existing methods, e.g. photometry, is that the area examined may be very small, of the order of 100μ in diameter, when the integrated intensity can be obtained directly by counting the total number of tracks in the spot, a feature of great potential value in microtechniques or where the intensity of reflexion is so small as to require the film to be placed very close to the crystal in order to obtain a record in a reasonable time. A further application is to the study of low-angle scattering.

The use of short wave-length radiation is preferable as the tracks are longer and more easily identified.

The author is indebted to Miss C. Dilworth (now at the Centre de Physique Nucléaire, Brussels) for assistance during preliminary experiments, and to Prof. C. F. Powell for valuable discussion and encouragement.

Acta Cryst. (1949). **2**, 339

An alternative interpretation for vector maps.

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(*Received* 20 *May* 1949)

The $|F|^2$ series (Patterson, 1934, 1935) which is used in the construction of vector maps can be defined for any number of dimensions by the three equivalent expressions

$$\int f(x_i)\,f(x_i+u_i)\,dx_i = \int f(x_i-\tfrac{1}{2}u_i)\,f(x_i+\tfrac{1}{2}u_i)\,dx_i$$
$$= \Sigma\,|F(h_i)|^2 \exp[-2\pi i \Sigma h_i u_i] \quad (1)$$

in an obvious notation. The physical interpretation of these expressions in terms of interatomic vectors is well known. The vector map for a given set of points can be generated by inverting the set in the origin and then superposing a series of images of the original set (appropriately weighted) using each point of the inverted set as origin.

There is a second series closely related to (1) which can be defined by the three equivalent expressions

$$\int f(x_i)\,f(u_i-x_i)\,dx_i = \int f(\tfrac{1}{2}u_i-x_i)\,f(\tfrac{1}{2}u_i+x_i)\,dx_i$$
$$= \Sigma\,F^2(h_i) \exp[-2\pi i \Sigma h_i u_i]. \quad (2)$$

The series (2), which involves $F^2(h_i)$ instead of the $|F(h_i)|^2$ of series (1), can now be given a physical interpretation. For a fixed u_i, the integrals (2) calculate the product of the values of the function f at the two points $\frac{1}{2}u_i-x_i$ and $\frac{1}{2}u_i+x_i$ and then integrate this product over the whole cell. The value of the expression (2) at the point u_i is thus a measure of the degree to which the crystal structure approximates to centrosymmetry about $\frac{1}{2}u_i$. If an atom at $\frac{1}{2}u_i-x_i$ has a counterpart at $\frac{1}{2}u_i+x_i$, there will be a contribution to the integral. If not, there will be little or no contribution. If the vector $\frac{1}{2}u_i$ coincides with the vector X_i which locates an atom center there will of course be a contribution since the atom itself always approximates centrosymmetry. The map of the function (2) for a set of points will thus consist of two types of points: (i) points of weight Z^2 at $2X_i$, where X_i is the atomic position co-ordinate, and (ii) points of weight $2Z_1Z_2$ at U_i, where $\frac{1}{2}U_i$ is the co-ordinate of the mid-point of the line joining the atoms Z_1 and Z_2 (the factor 2 appears because each pair makes a contribution for $+x_i$ and for $-x_i$). This map can be constructed for a given set

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