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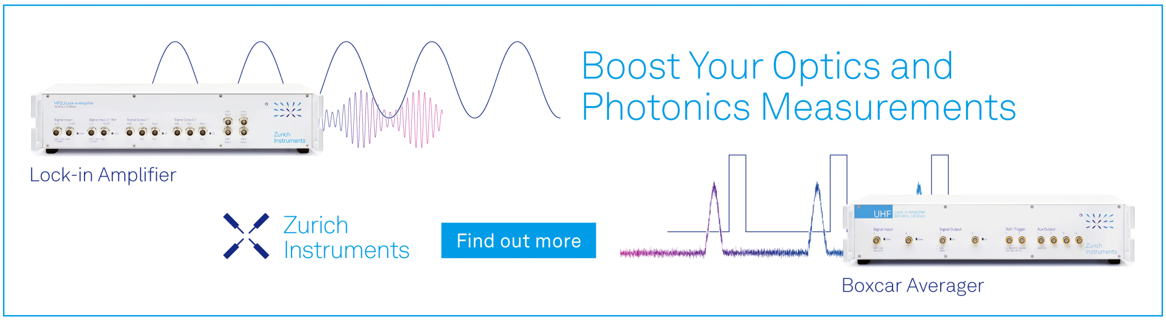

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Letter to the Editor

Comments on "Theoretical Main Beam Profiles for the Kratky Small Angle Camera"

[W. R. Krigbaum and R. W. Godwin, Rev. Sci. Instrum. 38, 398 (1967)]

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IN the publication, referenced above, by Krigbaum and Godwin (hereafter K and G) the authors demonstrated three operating modes, regions I,–III, for the Kratky camera and obtained the theoretical and practical primary beam profiles appropriate to these regions. It is the purpose of this letter to point our certain errors in the paper by K and G and to briefly describe the experience obtained by the author with this camera.

(1) At a trivial level there appear to be typographical errors in Eqs. (2) and (5) of K and G's paper.

Equation (2) should read

$$y_0' = x'(f+c)/(e+d+a+g)$$

and Eq. (5) should read

$$x_m^* = (s-E)(c+e+d+a+g)/f-E.$$

(2) More fundamentally there is some confusion over the discussion of region III. The paper states that progress through region III is marked by x_0^* becoming greater than x_m^* and this results in a reversal of the slope of the line truncating the upper portion of the profile. In Table II, Sec. C, of the paper x_0^* is shown as being greater than x_m^*: In fact the numerical values of x_m^* and x_0^* have been transposed for substitution of the listed parameters in the relevant equations and yield $x_0^*=0.202$ mm and $x_m^*=0.243$ mm. The true sequence of beam profiles is as follows:

(1) Regions I and II are given in K and G's paper.

(2) The border line of regions II and III will produce a triangular shaped profile the apex of which is the superposition of x_L^* and x_m^*.

(3) As region III is entered and $x_0^* < x_m^*$ the slope of the line truncating the profile will be the reverse of the similar line in region II (this occurs immediately on entering region III and not when $x_0^* > x_m^*$ as is stated by K and G).

(4) As E is increased eventually $x_0^* = x_m^*$ and the profile becomes triangular again.

(5) If E is further increased, $x_0^* > x_m^*$, all the source can be seen between x_m^* and x_0^* and the profile is trapezoidal.

K and G recommend the border line of regions II and III as the optimum setting but the problem exists of locating this region. Reliance on the combination of shape and width of the profile which is the method implicit in K and G's work requires:

(1) an accurate measurement of the projected source height s.

(2) the assumption of a square wave form x-ray source or alternatively a measurement of the fluctuations in the source and a subsequent weighting of each point of the theoretical primary beam profile. A method which makes no assumptions about the source profile and incorporates a measurement of s is given below (cf. Parrish[1]).

With the aid of K and G's Table I and a knowledge of the approximate size of s (taken from the manufacturer's specification) the smallest available entrance slit E for region I is chosen. The source can now be scanned by moving the height adjusters. Care must be taken to preserve the chosen angle of takeoff and this can be done by checking with a traveling microscope the effect on the ends of the camera of moving each height adjuster independently. For the camera used by the author a movement of n divisions of the height adjuster nearest the x-ray source must be accompanied by a movement of the other adjuster through $n/2$ divisions in the same direction and this alters the height of the camera with respect to the source by $0.0095n$ mm.

Over a small range of movement the width of the primary beam profile ($2b$) will exhibit a constant maximum value. If Δl is the distance moved by the camera with respect to the source then $\Delta l + 2E$ is the projected height of the source s and this value can be used in K and G's equations. The lowest value of the height adjusters where the con-

TABLE I. Peak-background readings for various entrance slits.

Entrance slit E	Region	Relative theoretical profile area	Parasitic scattering (2θ) (counts/min)								
			0.1	0.2	0.3	0.4	0.5	0.75	1	1.5	2
40 μ	I	27	82	29.0	27.2	27.4	27.9	26.1	25.9	27.5	28.8
60	II	58	157	39.3	38.0	34.1	32.4	32.7	30.3	32.0	29.7
150	III	221	···	99.2	79.1	74.1	68.6	67.0	63.9	56.8	56.2
140	III	708	···	···	···	141	124	118	115	104	103

stant maximum criterion is satisfied locates the lower edge of the source with the zero of the x axis in K and G's Fig. 1.

It is the experience of the writer that once this procedure has been carried out any region may be located and checked by using K and G's equations relating to $2b$ and l and setting the height adjusters to the calculated values.

It is known[2] that even with this collimation system some parasitic scattering, presumed to come from the bridge, extends above the principal section. To find the best region of operation to reduce this scattering, measurements were taken with an unattenuated primary beam and a 10 μ receiving slit from near the theoretical resolution value of 2θ out to $2\theta=2^0$. The results are summarized in Table I. It can be seen that the increase in primary beam intensity is not accompanied by a corresponding increase in parasitic scattering and if high resolution is not desired a significant improvement in signal-to-background ratio can be obtained by working in region III. This result is due to background level of radiation in the laboratory (measured as 20.7 counts/min with a xenon filled proportional counter and a pulse height discriminator set to measure Cu K_α radiation) being a greater fraction of the total counting rate for the smaller entrance slits and also in region III the more oblique incidence of the x rays on the bridge lessens the chance of parasitic scattering extending above the principal section.

Even with the Kratky camera long counting times are needed for the weakest scattering systems and it is important to stabilize the experimental conditions as far as possible. As a number of small angle scattering experiments consist of measuring the difference in scattering between a control specimen and a test specimen (particularly in the field of point defects and point defect clusters in metals where the difference between a perfect annealed specimen and a defect specimen is investigated), there are obvious advantages in collecting data from the two specimens during the same scan to overcome long term stability problems.

A detailed description of a double specimen holder in use in the writer's laboratory will be published later.

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[1] W. Parrish, Rev. Sci. Instrum. 38, 1779 (1967).
[2] O. Kratky and H. Leopold, Makromol. Chem. 62, 73 (1964).

Erratum

An Improved Method for High Reflectivity Ellipsometry Based on a New Polarization Modulation Technique

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EQUATIONS (11) and (12) for ϵ_1 should be modified to read, respectively,

$$\epsilon_1=\sin^2\theta+\sin^2\theta\cdot\tan^2\theta\cdot\frac{N^2-(1-N^2)S^2}{[1\mp(1-N^2)^{\frac{1}{2}}\cdot(1-S^2)^{\frac{1}{2}}]^2}$$

and

$$\epsilon_1=\sin^2\theta+\sin^2\theta\cdot\tan^2\theta\cdot\frac{N^2-(1-N^2)(1-C^2)}{[1+C\cdot(1-N^2)^{\frac{1}{2}}]^2}.$$