small gamma-ray free neutron sources. Thus; over-all operation checks are periodically made with a small gamma-ray source to ensure that the equipment is connected and functioning properly.

* This document is based on work performed for the AEC by Carbide and Carbon Chemicals Corporation, Oak Ridge, Tennessee.
[1] P. R. Bell, Phys. Rev. **73**, 1405 (1948).

Note on Sealing Nylons Films to Geiger Counters*

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August 22, 1949

IT was thought useful to report a very simple and certain method of attaching a thin Nylon sheet as the end window of a Geiger counter. As is evident from Fig. 1, the seal is of the compression type. The bonding material is ordinary rubber cement. (A commercial brand of the latter called "Neetstik" was employed.) The cement is diluted with several parts of benzene until it is sufficiently thin to be spread fairly uniformly with a small brush. The procedure is to apply two or three thin coats to the upper and lower surfaces, respectively, of the annular rings A and B in Fig. 1. To avoid later shrinkage, these are allowed to dry for about an hour. Following this, the Nylon sheet, cut oversize, is lightly laid on A, after which wrinkles are removed by pulling gently on the protruding edges. Finger pressure is then applied to the top surface of the Nylon to make it stick firmly to A. A heated piece of wire or other heated sharp instrument may be employed to clear the screw holes. This procedure, rather than punching with a cold instrument, avoids wrinkling the film. Ring B can then be attached in the obvious manner, with excess screw pressure being avoided. The purpose of the cement on B is to prevent cutting the Nylon by the ring. Surplus Nylon extending beyond the outer periphery of the rings can be melted off by means of the same heated wire.

The entire procedure, save for the initial drying of the cement, requires but a few moments, and is extraordinarily easy. No failures with this method have been experienced by the writer. A further advantage of the process is that the solvent will have evaporated from the adhesive before the sheet is applied, and thus does not weaken the edge of the window. With counters of the dimensions shown, and about 4 in. long protruding into an evacuated chamber, the writer has been able consistently to employ 6 cm pressure in the counter (1 cm alcohol and 5 cm argon) with $\frac{1}{2}$-mg/cm^2 Nylon windows. The counter plateaus are in excess of 200 v.

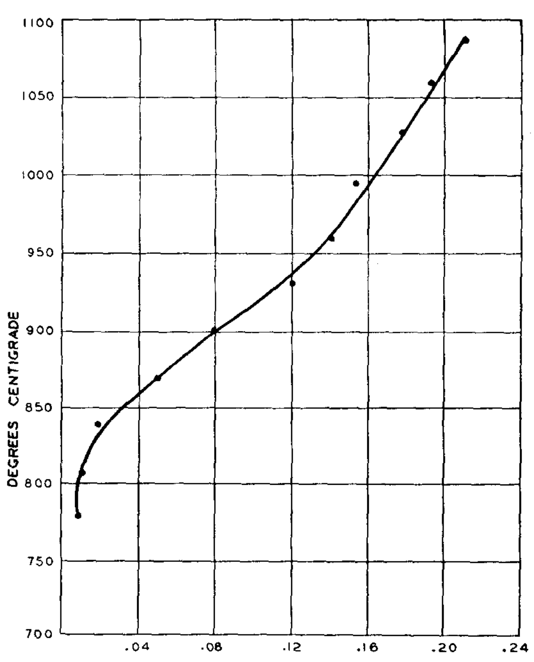

FIG. 1.

When employing Nylon window counters, it is necessary to take into account the diffusion of the counter gas through the Nylon. This effect for Nylon films has been described by others.[1] In the author's experiments this difficulty was reduced by keeping the counters open to a larger ballast volume and to a reservoir containing absolute alcohol maintained at melting ice temperature. The counter plateaus were checked from day to day.

The above bonding material has been employed also to attach zapon films to wire frames to be used as backing material for beta-spectrometer sources.

* This work was supported by the Joint Program of the ONR and AEC.
[1] J. A. Simpson, Jr., Rev. Sci. Inst. **19**, 733 (1948). This author pointed out that water vapor may pass through the Nylon into the counter if the latter is immersed in a medium which bears water vapor.

Focusing in a Semicircular Magnetic Spectrometer

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THE line shape produced by a semicircular focusing spectrometer is currently of interest in the field of beta-spectroscopy. Although the boundary conditions imposed by a two-dimensional source and the defining slits have prohibited an exact solution of the three-dimensional problem, approximate solutions have been proposed by Wooster,[1] followed by Li[2] and by Tyler and Lawson.[3] A two-dimensional problem in which the particles are assumed to originate and remain in a plane perpendicular to the magnetic field, has been discussed in an approximate manner by Siegbahn.[4] The line shapes resulting from the two-dimensional treatment preserve the essential features predicted by the three-dimensional theories.

The purpose of this paper is to present an exact graphic treatment of the general two-dimensional problem. Using the technique discussed below, the line shape may be quickly determined for various arrangements of the sample and defining slits.

Figure 1 shows the circular trajectory of a particle projected at

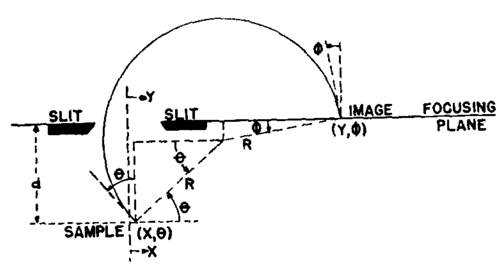

FIG. 1.

an angle θ from a point x, on the line source. The corresponding quantities ϕ and y define the trajectory at the image. Since mono-energetic particles are considered, the trajectory radii R, are the same for all particles. From Fig. 1,

$$\theta=\sin^{-1}\left(\frac{d}{R}-\sin\phi\right) \tag{1a}$$

$$x=y-R\cos\phi-R\left(1-\left(\frac{d}{R}-\sin\phi\right)^2\right)^{\frac{1}{2}}. \tag{1b}$$

The Jacobian of this transformation is

$$J\begin{pmatrix}x\theta\\ y\phi\end{pmatrix}=\frac{-\cos\phi}{\left(1-\left(\frac{d}{R}-\sin\phi\right)^2\right)^{\frac{1}{2}}}. \tag{2}$$

Since the particles are assumed to be ejected isotropically from the source, the intensity I_0, of the particles per unit source length and

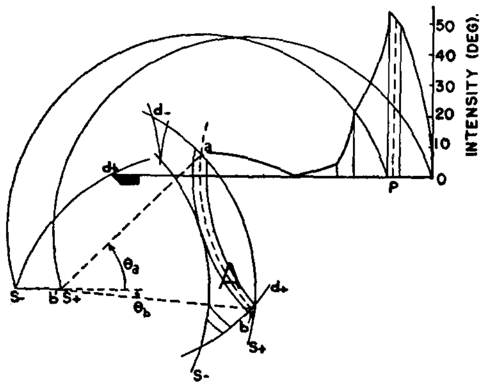

FIG. 2. Construction of two-dimensional line shape.

unit angle, is related to the corresponding intensity $I(y, \phi)$ at the image by the following equation:

$$I_0 dx d\theta = I_0 J\begin{pmatrix} x\theta \\ y\phi \end{pmatrix} dy d\phi = I(y, \phi) dy d\phi. \qquad (3)$$

The line density $V(y)$, is obtained by substituting (2) into (3) and integrating over ϕ.

$$V(y) = I_0 \sin^{-1}\left(\frac{d}{R} - \sin\phi\right)_{\text{limits}} = I_0(\theta_a - \theta_b). \qquad (4)$$

The determination of the θ limits of Eq. (4), and thus the construction of the line shape, is shown in Fig. 2. Here both sample

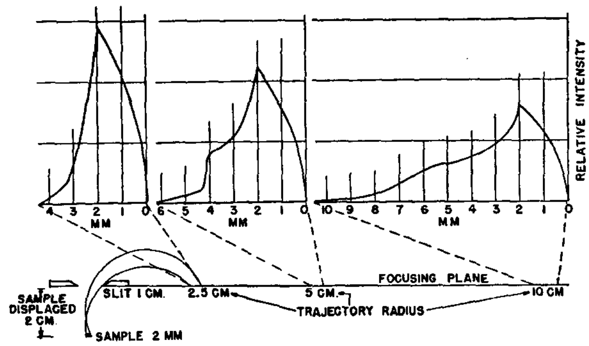

FIG. 3. Variation of line shape with focusing radius.

and slit widths have been exaggerated for clarity of construction. The intersections of the four circles, all with radius R, centered at $s+$, $s-$, $d+$, and $d-$ define an area A, which contains the centers of all the particle trajectory circles which can originate from the source and pass through the slits. To determine the intensity $V(y)$, at an arbitrary point P, of the image, a circle of radius R is constructed with P as center. The intersections, a and b, of this circle with the periphery of the area A, determine the limiting angles θ_a and θ_b. Since the point, a is an intersection with the $s+$ circle, θ_a is measured from the positive source limit, $s+$. On the other

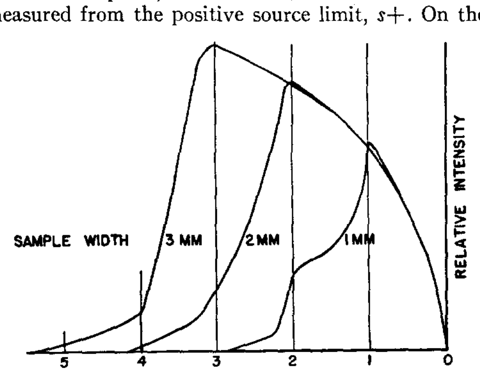

FIG. 4. Variation of line shape with source width. Trajectory radius 2.5 cm, sample displaced 2 cm, slit width 1 cm.

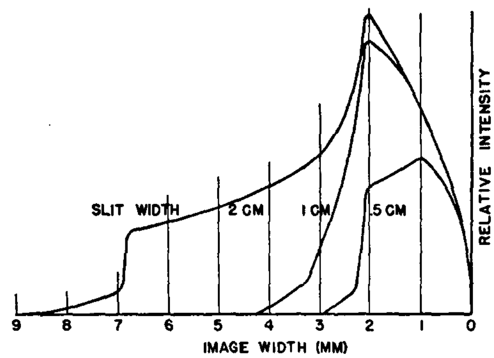

FIG. 5. Variation of line shape with slit width. Trajectory radius 2.5 cm, sample displaced 2 cm, sample width 2 mm.

hand the positive slit, $d+$, determines θ_b, which is then measured from the intersection, b', of the source and a circle (radius R) with b as center. Other points of the image may be obtained in the same manner to complete the definition of the line shape.

In Fig. 2 the existence of five different topological zones forming the complete image presents no graphical difficulties. The number of zones depends upon the values of the various parameters: slit width, sample width, sample displacement, and trajectory radius. On the other hand the presence of a varying number of zones makes analytic expressions for the line shape awkward, although the functions are of a simple nature.

Figures 3–5 illustrate the effects of varying the parameters which determine the line shape. Figure 3 shows the typical line broadening and reduction of peak intensity with increasing trajectory radius. In Fig. 4 it can be seen that small increases in peak intensity, resulting from source widening, involve considerable loss in resolving power. Figure 5 stresses the importance of slit setting. As the slit width approaches the dimension of the sample, appreciable increase in resolving power is gained only by a considerable loss in peak intensity.

In the conventional fixed radius spectrometer (Fig. 6) the sample and the focal line are colinear; i.e., in the above equations $d=0$, and the Jacobian reduces to minus one. Since $\theta = -\phi$, Eq. (4) becomes: $V(y) = I_0(\phi_b - \phi_a)$, where the points a and b determine ϕ_a and ϕ_b. The construction is simplified, since both angles are measured from P. By judicious choice of the spectrometer

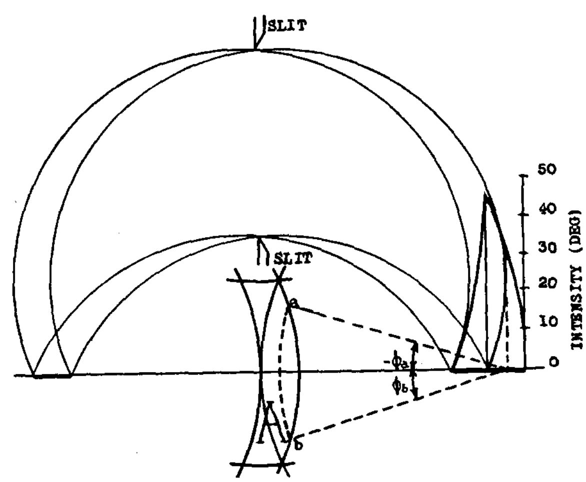

FIG. 6.

parameters, the line shape can be represented by only two zones (Fig. 6). For this special case, analytic expressions for the line shape may be advantageous.

This project was jointly supported by the AEC and the ONR.

[1] W. A. Wooster, Prog. Ray. Soc. A114, 729 (1927).
[2] K. T. Li, Proc. Camb. Phil. Soc. 33, 164 (1937).
[3] A. Tyler and J. Lawson, Thesis, Univ. of Michigan (1939).
[4] K. Siegbahn, Arkiv. f. Mat., Ostr., och Pysik, 30 (1944).