

## True Surface Densities of Protein Films

It has been disputed<sup>1</sup> whether Gorter's<sup>2</sup> method of spreading proteins to form surface films can really give a homogeneous film unless either (a) very dilute solutions are used for spreading, or (b) very long times, from 1 to 24 hours, are allowed before the force-area measurements are made. In the case of gliadin films, however, a vindication of the earlier method has been published<sup>3</sup> and it appears from the figures quoted here that equilibrium is achieved within a very few minutes after the film is spread.

Further measurements suggest, however, that although, as Jenkins and Taylor show, the surface-density figures for longer times are lower because of contamination of the surface, there is some merit in performing these measurements. The figures in the accompanying table which have been obtained for zein, show that the initial drop in surface density with time is much more rapid than the later fall, but not sufficiently rapid to avoid some contamination.

TABLE 1.

Time (mins.)	5	5	5	10	10	30	30	60	150	290	420	1400
$d \times 10^7$	1.32	1.40	1.35	1.31	1.33	1.26	1.32	1.19	1.16	1.10	1.07	0.89
Mean $d$	1.36			1.32		1.29						

It is clear that the surface density of the completely spread, but uncontaminated film, is obtained by extrapolating the shallow part of the curve to zero time, when a value of  $1.21 \times 10^{-7}$  is obtained for  $d$ . A somewhat similar curve is obtained, though with less regularity, for gliadin from the averaged figures of Jenkins and Taylor.

Measurements on hen's egg albumen show a similar trend. The spreading here seems to be considerably slower, and at least half an hour is required for complete spreading. The protein films are fully reversible and can be recompressed an indefinite number of times, without alteration in the shape of the compression curves. The figures for four different spreadings are:

TABLE 2.

Time (mins.)	10	15	45	60	80	90	180	Extrap. density
(1)		1.20		1.10		1.06		1.13
(2)	1.37		1.19			1.13	1.10	1.165
(3)	1.13		1.09			1.06		1.125
(4)	1.14		1.07		1.02			1.13

The extrapolated densities almost entirely smooth out the fairly wide variations between individual measurements at short spreading times, and the mean value of 1.14 is closely similar to results obtained in the same way for gliadin and zein.

All the measurements were made on a substrate of 0.01N sulphuric acid at room temperature.

There seems to be little doubt that this compromise between the methods of Mitchell and Jenkins and Taylor is the most satisfactory means of overcoming irregularities due to accidents of contamination and initially uneven spreading of the protein film.

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<sup>1</sup> Mitchell, *Trans. Faraday Soc.*, **33**, 1129 (1937).

<sup>2</sup> Gorter *et al.*, *Proc. Acad. Sci. Amst.*, **89**, 371 (1925) *et seq.*

<sup>3</sup> Jenkins and Taylor, *NATURE*, **142**, 291 (1938).

## Diffuse Reflexion of X-Rays

PROF. G. E. M. JAUNCEY<sup>1</sup> derives the formula:

$$\varphi_{mB} - 2\theta_B = 2(i - i_B) \sin^2 \theta_B. \quad (1)$$

for the relative position of a Bragg reflexion and the so-called "modified reflexion". The symbols are defined as follows:  $i$  is the glancing angle of incidence on the crystal plane for which  $\theta_B = i_B$  is the Bragg angle:  $\varphi_{mB}$  is the angle between the incident ray and the direction of scattering of the modified reflexion:  $i - i_B$  is supposed to be small. The disposition of the incident ray  $I$ , the scattered ray  $S$ , and the crystal plane are shown in Fig. 1. Prof. Jauncey deduces (1) from a formula of Sir William Bragg's, and it is obtained from quite different assumptions by Raman and Nath and by Zachariasen. In fact (1) is only an approximation to a formula due to Faxén which may be put in the form:

$$d \sin \varphi = \lambda \cos(\varphi - i), \quad (2)$$

where  $d$  is the spacing of the plane for which the Bragg angle is  $\theta$ :  $\varphi (= \varphi_{mB})$  and  $i$  are as shown in Fig. 1. Using Bragg's Law to eliminate  $d$  and  $\lambda$  from (2),

$$\sin \varphi = 2 \cos(\varphi - i) \sin \theta. \quad (3)$$

That (3) is an exact form of (1) may be proved by varying  $i$  and  $\varphi$  for constant  $\theta$ , giving

$$\cos \varphi \delta \varphi = -2 \sin \theta \sin(\varphi - i) (\delta \varphi - \delta i). \quad (4)$$

When the angle of incidence changes from  $\theta$  to  $i$ ,  $\delta i = i - \theta$ , and at the same time the angle of scattering changes from  $2\theta$  to  $\varphi$ , so that  $\delta \varphi = \varphi - 2\theta$ : if  $i$  is nearly equal to  $\theta$ ,  $\varphi = 2\theta$  and  $\varphi - i = \theta$  approximately, so that (4) gives

$$\begin{aligned} \cos \varphi (\varphi - 2\theta) &= -2 \sin^2 \theta (\varphi - 2\theta - i + \theta) \\ \text{or } \varphi - 2\theta &= 2(i - \theta) \sin^2 \theta, \end{aligned} \quad (5)$$

which is identical with (1) when the suffixes are introduced.

The geometrical significance of Faxén's formula (2) is shown in Fig. 2. Here  $O$  is the origin of reciprocal space,  $B$  the Bragg spot, and  $P$  the modified reflexion. Faxén's formula states that  $P$  lies in the line joining  $B$  to  $C$ , the centre of the sphere of reflexion. The angles  $i$  and  $\varphi$  are shown on the diagram,  $CN$  being normal to  $OB$ . The formula follows at once from the geometry of the triangle  $OCB$ .

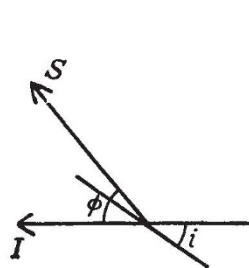


Fig. 1.

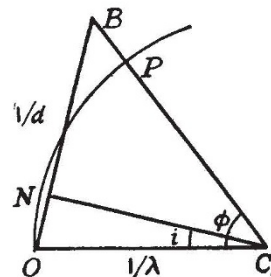


Fig. 2.

The physical interpretation of Faxén's formula is that the surfaces of constant intensity surrounding the Bragg points are spheres: I have found that the pattern given by aluminium<sup>2</sup> conforms to this rule, but at the time had not observed that this amounted