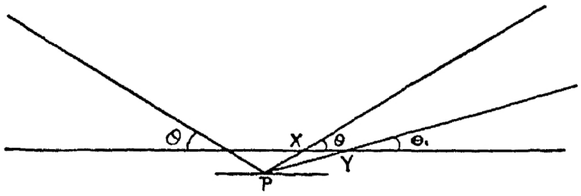
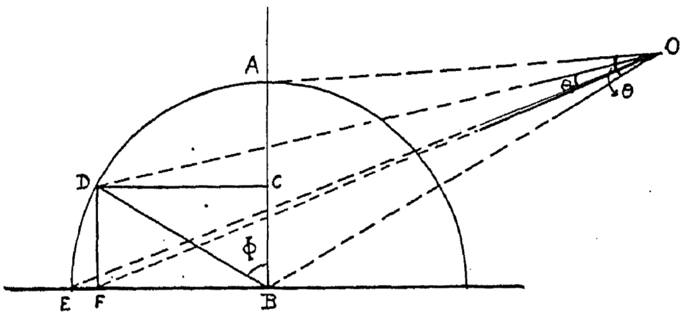
Variation of Intensity along an Electron Reflection Ring

In examining the structure of a polycrystalline surface by electron reflection, the patterns obtained consist of rings in the form of semi-circles. The reflected rays lie on a cone with the incident beam as the axis. The electrons reflected along a generator of this cone which lies in the plane of incidence, leave the material by the shortest path; while the electrons moving along any other generator have to travel over a longer distance. Those electrons which travel over a longer distance in the material are absorbed more than those which have a shorter path in it. Thus we can see that the intensity of a ring in a reflection pattern—which is merely the section of cones of reflection—will be maximum along the planes of incidence, and will diminish as we go further and further away from this plane.





In the figure ADE is the ring, BAO the plane of incidence, DO any ray making an angle DBA $= \phi$, and the angle DOF $= \theta$, the angle of emergence of the ray OD. Since OA lies in the plane of incidence, the angle BOA, the angle of emergence of the ray OA is equal to the glancing angle θ. Further X and Y are the paths travelled respectively by the central ray OA and the ϕ-ray OD, after reflection at P within the material. If we assume that the reflecting block has a flat surface we get from the geometry of the figure

$$\sin \theta_1 = \sin \theta \cos \phi$$

and

$$y = x \sec \phi.$$

It is quite natural to suppose that the electrons like X-rays obey an exponential law of absorption. On this supposition we get

$$I_\phi = I_{\phi_0} e^{-\mu x \text{ (see } \phi - 1)}$$

where I_{ϕ_0} is the intensity for $\phi = 0$. For a definite specimen and a particular ring, x would be fixed and we may write $\mu x = A$, a constant.

In column two of the table are given the values of I_ϕ for different values of ϕ and A, these are calculated on the assumption that $I_{\phi_0} = 100$ in each case. Column three gives the relative intensities obtained with a microphotometer, here also for comparison the values are expressed with $I_{\phi_0} = 100$. The specimen used

TABLE

Angle	I_ϕ Calculated			I_ϕ Observed
	A = 1	A = 3	A = 10	
0°	100	100	100	100
1°	100	100	100	100
15°	97	90	70	98
30°	85	63	22	87
45°	66	29	2	68
60°	37	5	negligible	34
75°	6	negligible		5
80°	1			negligible
85°	negligible			

to produce the pattern was a polished piece of silver etched to give rings. In this case the best agreement between the observed and calculated values of I_ϕ is obtained for $A = 1$. A qualitative consideration of the penetrating power of the fast electrons also shows that A or μx should be of the order unity for 30 K.V. electrons.

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