(over the last 2·28 mm. of path) is 2,900 ± 230 pairs of ions. If this be accepted, the maximum specific ionization cannot well be less than 3,400 ion pairs per mm.—or one half, rather than one third, of the maximum specific ionization due to an α-particle.

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Diffuse Reflexion of X-Rays

IN a recent note Preston[1] has commented upon the agreement of his experimental results for the diffuse scattering of X-rays by single crystals of aluminium with the predictions of both the Preston-Bragg block hypothesis and a formula derived by Faxén. It seems necessary to correct the impression which might thereby be formed that the Preston-Bragg hypothesis is reconcilable with the Faxén-Waller theory. This is indeed not the case. It has been shown by Laue[2] that if the intensity of scattering from a finite crystal is plotted in the reciprocal lattice space as a function of the end-point of the vector

$$\vec{S} = \frac{\vec{\varepsilon} - \vec{\varepsilon}_0}{\lambda}$$

($\vec{\varepsilon}_0$, $\vec{\varepsilon}$ unit vectors in the direction of incident and reflected ray, λ wave-length) drawn from the origin of the reciprocal lattice, then the resulting distribution of scattering power is periodic with the periods of the reciprocal lattice, so that in particular there is the same distribution about every reciprocal lattice point. On the other hand, the Faxén formula discussed by Preston is obtained by specialization (see below) from a general expression derived by both Faxén[3] and Waller[4] for the first approximation to the coherent diffuse scattering from a monatomic cubical crystal. This general expression can be written in the form :

$$I \sim \frac{(\vec{S}, \vec{A}_1)^2}{\nu_1{}^2} + \frac{(\vec{S}, \vec{A}_2)^2}{\nu_2{}^2} + \frac{(\vec{S}, \vec{A}_3)^2}{\nu_3{}^2},$$

where $\vec{A}_1$, $\vec{A}_2$, $\vec{A}_3$ are unit (and orthogonal) vectors defining the directions of oscillation of those three acoustical vibrations the wave vector $\vec{w}$ of which satisfies the Faxén-Waller vector condition (namely, $\vec{w} = \vec{S} - \vec{B}$, where $\vec{B}$ is that reciprocal lattice vector the end-point of which lies nearest to that of $\vec{S}$) and ν_1, ν_2, ν_3 are the respective frequencies of these vibrations. Owing to the occurrence in this expression of the cosines of the angles between the vector $\vec{S}$ and the vectors of oscillation, it is clear that the expression must lead to a different distribution of scattering power about each point of the reciprocal

lattice. In a paper which I have in preparation, the general Faxén-Waller expression has been evaluated for various relative values of the three elastic constants c_{11}, c_{12}, c_{44} of a cubic crystal, and the marked dependence of the scattering power upon the elastic anisotropy demonstrated. For example, for sodium single crystals, using the values of the elastic constants determined by Quimby and Siegel[5], namely, $c_1 = 0·760\ c_{11}$, $c_{44} = 0·914\ c_{11}$ (at 200° K.), with cubic anisotropy $c_{11} - c_{12} - 2c_{44} = -1·59\ c_{11}$, the section of the contours of isodiffusion of the 200 and 110 reflexions in the 200,020 plane of the reciprocal lattice approach, in the limiting case of long elastic waves, that is, proximity to the Bragg spot, the shape shown in the accompanying diagram.
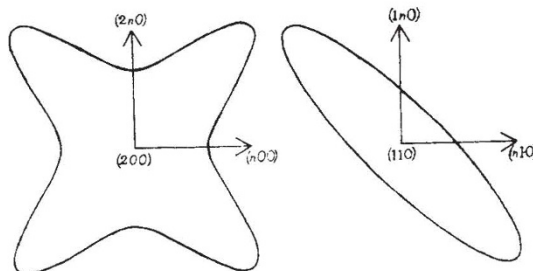
THEORETICAL CURVES OF ISODIFFUSION FOR SODIUM SINGLE CRYSTALS.

Experiments to test the existence of these different distributions about different Bragg spots are being carried out in this Laboratory, although it should be pointed out that the earlier work of Laval[6] gives clear indication that these differences do exist in the manner required by the Faxén-Waller theory.

The special assumptions made by Faxén in arriving at the simple formula discussed by Preston included that of spherical isotropy for the elastic properties of the cubical crystal, namely, the relation $c_{11} - c_{12} = 2c_{44}$, which condition is fairly closely satisfied by aluminium ($c_{12} = 0·57\ c_{11}$, $c_{44} = 0·26\ c_{11}$, $c_{11} - c_{12} - 2c_{44} = -0·09\ c_{11}$); consequently the differences here will be less marked and more difficult to determine.

It should be stressed that we have in the diffuse scattering phenomenon a much finer method of exploring the vibrational spectrum of a crystal than is possible by studying, for example, the specific heat or the Debye-Waller factor; for whereas there one is dealing with averages over all directions of propagation of the elastic waves, here, in the diffuse scattering for a given crystal setting and direction of scattering, only those vibrations the wave-lengths and directions of propagation of which lie within restricted limits contribute to the scattering (Faxén-Waller vector condition).

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