print of the diffraction pattern. (The digital system used in this work has been described elsewhere by Billingsley, 1971). The area of the pattern that was digitized is indicated by the white box in Fig. 1(a). This portion of the pattern was divided into 827 x 767 samples spaced at 30 μm intervals. Each sample, called a pixel, was assigned a value from zero to 255, depending on the film density at that point; zero is black and 255 is white.

After the pattern was digitized, the pixel values were searched for evidence of a diffuse scattering signal. This examination indicated the existence of a weak signal, along the [111] and [111] directions, having the same symmetry (approximately 2mm) as the Bragg signal. Since the pattern symmetry is used in a later step in the processing, a geometric correction was applied to the pattern to ensure 2mm symmetry. This geometric correction mapped quadrilaterals in the input pattern into rectangles in the output pattern in such a fashion that the intensity centers of the Bragg maxima defined a pixel network with 2mm symmetry; the axes of mirror symmetry were aligned with the horizontal and vertical axes of the output picture.

In order to increase the signal-to-noise ratio (SNR) of the pattern, it was first necessary to generate independent patterns from the geometrically corrected pattern. This was done by: (i) a 180° rotation of the pattern about the twofold axis, (ii) a 180° rotation about the horizontal axis of the pattern, and (iii) a 180° rotation about the vertical axis of the pattern. Next, a new pattern was constructed by superimposing and averaging these three patterns with the original pattern. The SNR of this pattern is a factor of 2 larger than that of the original pattern, and (iii) a 180° rotation about the vertical axis of the pattern. The SNR of this pattern is a factor of 2 larger than that of the original pattern. The final step in the computer processing was a linear contrast stretch to enhance the diffuse scattering signal. An examination of pixel values and local gray-scale histograms indicated that the diffuse scattering signal (and virtually the entire Bragg signal) lies between 41 and 65 on the gray scale. The stretch was accomplished by setting all pixels with values of 41 or below to zero and all those of 65 or above to 255, with the remainder linearly interpolated between zero and 255.

In order to highlight the location of the diffuse scattering signal, two methods of computer display were utilized. In the first method the picture was contoured by setting every tenth gray level to white. The results of this contouring are shown in Fig. 2(a) where types 1, 2, and 3 superlattice maxima are evident. Although the pixel values in the processed pattern indicated the presence of the type 4 superlattice maximum, a pattern with finer contouring has not been presented since this seemed to degrade the overall quality of the display. Instead, an alternative display method was employed. In this method the first γ bits of each pixel were set to zero, resulting in an artificial contour effect; a plot of the input gray level vs. the output gray level, after setting the first γ bits to zero, is a saw-toothed function. In Fig. 2(b) the first four bits of each pixel have been set to zero, and all four superlattice maxima can now be distinguished.

Reference
(in the case of polycrystals), where \( k' \) and \( k'' \) are the normalization factors, \( i(\lambda) \) the distribution of the incident neutrons, \( F_{hi} \) the structure factor, \( d_{hi} \) the interplanar spacing, \( A(\lambda) \) the absorption factor, \( j \) the multiplicity factor and \( Y(\lambda, F) \) the extinction factor.

The present experiment was carried out on a four-circle automatic diffractometer installed at the 300 MeV Tohoku University electron linac. As a specimen, a CuCl single crystal was used, which was the same as that utilized by Sakata, Hoshino & Harada (1974) in their study of the temperature factor, because the nature of this specimen was known from the previous study.

In order to obtain the extinction factor \( Y(\lambda, F) \) from equations (1) and (2), it is necessary to obtain the incident neutron distribution \( i(\lambda) \) as accurately as possible. Two different methods were used to determine \( i(\lambda) \):

(i) direct measurement of the spectrum \( i(\lambda) \) by placing a neutron detector in the path of the incident beam with a fine slit (3 mm width) in front of the counter,

(ii) analysis of powder data of CuCl on the basis of the equation (2).

The results are shown in Fig. 1 where the solid curve shows \( i(\lambda) \) determined by method (i) and the circles show the results obtained by method (ii). It can be seen that there is good agreement between them.

Once the incident neutron distribution \( i(\lambda) \) was obtained, the integrated intensities for 111, 222 and 333 Bragg reflexions from the CuCl single-crystal specimen were measured for various wavelengths. A similar analysis of the data was made on the basis of equation (1). The results are shown in Fig. 1. The observed points deviate from the solid curve \( i(\lambda) \); in particular the deviation is large for the longer wavelengths. From this deviation one can determine the extinction factor \( Y(\lambda, F) \). In Fig. 2 \( Y(\lambda, F) \) extracted from Fig. 1 is shown. As expected, the results show that the extinction of the 111 reflexion is stronger than that of the 222. Incidentally the structure factors of 111, 222 and 333 are 20-44, 1.34 and 7.45 barns, respectively (Sakata et al., 1974).

It can be proved that the extinction factor \( Y(\lambda, F) \) written for \( \Omega \) and \( \Omega-2\theta \) scanning methods also remains valid when applied to TOF neutron diffraction. Comparison of the present results with recent extinction theory (Becker & Coppens, 1974) was thus made. In Fig. 2 the solid curves show the calculations, where the mosaic spread parameter is adjusted to fit the calculated \( Y(\lambda, F) \) to the results obtained for the 111 reflexion by assuming a type I crystal. It is seen that the wavelength dependence of the extinction is reproduced fairly well by the theory.

As demonstrated by the present experiment, it is apparent that the TOF neutron diffraction technique has a great advantage for investigation of the wavelength dependence of the extinction factor. The details of the present study will be reported shortly.

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**References**


