

a  $(\bar{1}13)$  plane (provided that the angular range of  $(\bar{1}13)$  normals is greater than  $1^\circ$ ), since there exists a  $(\bar{1}13)$  normal  $C'$  inclined at  $90 - \theta (= 34.9^\circ)$  to the  $(\bar{1}\bar{1}1)$  reflexion  $C$ . This composite  $(\bar{1}\bar{1}1)$  and  $(\bar{1}13)$  reflexion has its direction represented by the point  $D$  which is inclined to the  $(004)$  reflexion  $B$  at an angle of  $2.4^\circ$ .

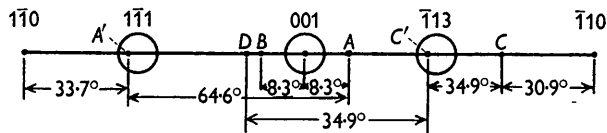


Fig. 2. A section of the standard stereographic projection of a cubic crystal (not to scale) showing the relative positions of the incident beam and reflected rays.  $A$ , incident beam;  $B$ ,  $(004)$  reflexion;  $C$ ,  $(\bar{1}\bar{1}1)$  reflexion;  $D$ , the composite  $(\bar{1}\bar{1}1) + (\bar{1}13)$  reflexion.

Thus it can be seen that when a sufficiently imperfect copper crystal is set in an X-ray beam in the orientation indicated in Fig. 2 one obtains the primary  $(004)$  and  $(\bar{1}\bar{1}1)$  Bragg reflexions and a double reflexion from the  $(\bar{1}\bar{1}1)$  and  $(\bar{1}13)$  planes. This is illustrated in Fig. 3, which represents a section through the crystal parallel to the  $(110)$  plane.

Although the double reflexion (unaccompanied by the primary  $(004)$  reflexion) can be obtained with a perfect copper crystal, it can be detected more readily in the case of an imperfect crystal, since the variation in orientation of the reflecting planes allows a wider range of the setting angle at which the double reflexion will occur. In fact, under normal experimental conditions, the reflexion was frequently observed quite by chance. No unduly long exposures were required. The photograph of Fig. 1 had an exposure of 10 mA.hr. at 50 kV.

The foregoing description has been concerned only with the ideal case of a parallel beam and with reflexions and

reflecting normals parallel to the  $(110)$  plane, whereas in actual fact the reflexions will suffer considerable peripheral elongation due to the spread of the reflecting normals in a direction perpendicular to the  $(110)$  plane.

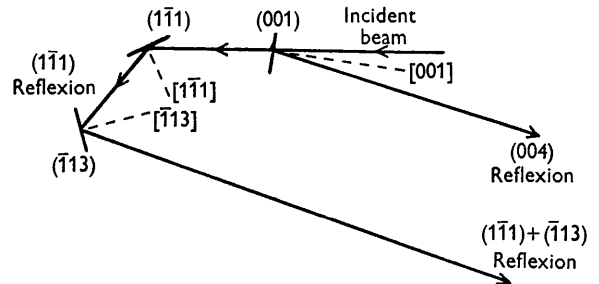


Fig. 3. A section through the crystal parallel to the  $(110)$  plane showing the primary and double reflexions.

The verification of the hypothesis of double reflexion was quite simple. The photograph shown in Fig. 1 was taken from a copper crystal which was set up in the orientation indicated by the point  $A$  of Fig. 2 and oscillated slightly about a mean position. The doublet separation of the double reflexion is equal to that of the  $(\bar{1}13)$  reflexion (the separation of the  $(\bar{1}\bar{1}1)$  reflexion being negligible), whilst the minimum angular separation of the  $(004)$  reflexion and the double reflexion was approximately  $2.4^\circ$ , which is consistent with the angular separation of the points  $B$  and  $D$  of Fig. 2.

In conclusion, the author wishes to thank Dr W. A. Wood of the Baillieu Laboratory, University of Melbourne, and Dr A. Matheson of the Division of Industrial Chemistry, C.S.I.R.O., for their interest and helpful advice.

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**$\beta$ -Diglycylglycine.**† By EDWARD W. HUGHES and WALTER J. MOORE‡, *Gates and Crellin Laboratories, California Institute of Technology, Pasadena, California, U.S.A.*

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In a brief survey examination Lenel (1932) has reported unit-cell data for two anhydrous forms of diglycylglycine. His constants for the  $\beta$ -form are:

monoclinic,  $a = 14.6$ ,  $b = 4.79$ ,  $c = 11.67$  kX.;  $\beta = 105\frac{1}{2}^\circ$ .

There are four molecules per cell. No space group was given, and the measurements were made on rotation and Weissenberg photographs taken about the needle axis,  $b$ .

We have grown needle-like crystals of diglycylglycine by slowly cooling a saturated 40% aqueous ethanol solution of the substance. After preparing rotation and zero-layer Weissenberg photographs about the needle axis we found, assuming monoclinic symmetry, constants which agree with Lenel's within experimental error:

$a = 14.92$ ,  $b = 4.80$ ,  $c = 11.67$  kX.;  $\beta = 105^\circ$ ,

and it seems probable that we had the form he called  $\beta$ . However, these needles show oblique extinction between

crossed Nicol prisms, and Laue photographs taken perpendicular to the needle axis in various orientations show no symmetry planes. A first-layer Weissenberg picture about the needle axis confirms that the Laue symmetry is  $\bar{1}$  and that the crystal is grossly triclinic. Although it is barely possible that we have discovered a third form of diglycylglycine it seems more likely that Lenel erred in calling the  $\beta$ -form monoclinic.

The cell is simple and contains four molecules so that even if the space group is  $P\bar{1}$  there are two non-equivalent molecules per cell; if the space group is  $P1$  there are four non-equivalent molecules. It is therefore an unfavorable substance for detailed examination and we have abandoned it. It should be noted that we have not determined the crystal angles  $\alpha$ ,  $\beta$  and  $\gamma$ , and the proper constants to be recorded in place of those above are:

$d_{100} = 14.41$ ,  $b = 4.80$ ,  $d_{001} = 11.27$  kX.;  $\beta^* = 75^\circ$ .

We are indebted to Prof. Eugene Pacsu for the sample of diglycylglycine.

#### Reference

LENEL, F. V. (1932). *Z. Kristallogr.* **81**, 224.

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