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BRILLOUIN ZONE BOUNDARY CONSTRUCTION FOR INDEXING BRAGG CONTOURS AND KIKUCHI LINES

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# University of California Ernest O. Lawrence Radiation Laboratory

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K. H. G. Ashbee and J. W. Heavens

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One consequence of the distribution in orientation of Bragg diffracting planes in an elastically bent foil is that simultaneous diffraction occurs from  $\pm g$  pairs, where  $g$  is the reciprocal lattice vector to a diffracting plane. If such Bragg contour pairs are indexed, then the variation in orientation with respect to the incident electron beam is known. This note describes a construction by means of which Bragg contour pairs may be indexed by inspection.

Referring to Fig. 1, the Ewald sphere radius is  $\frac{1}{\lambda}$ , where  $\lambda$  is the wavelength of the electron beam, and the half spacing of first order reciprocal lattice planes is  $\frac{1}{d}$ , where  $d$  is the corresponding spacing in direct space. The angle subtended by the zero and first order planes at the center of the Ewald sphere is  $\alpha = \sin^{-1} \left( \frac{\lambda}{d} \right)$ . Thus, to represent a pair of first order Bragg contours on a stereographic projection, measure  $\pm\alpha$  from, and along the normal to, the zero order plane. The traces of the required Bragg contours pass through these points and parallel to the zero order trace. In practice, it is desirable to enlarge a stereographic projection of the zero order planes before making the construction. As an example, a stereographic projection of first order Bragg contours up to line 27 for an f.c.c. crystal is given in Fig. 2; if required, higher order contours can easily be added. Figure 2 is, of course, a map of first order Brillouin zone boundaries.

One use of this construction is the measurement of large elastic fields in electron microscope specimens. Figure 3(a) shows a pattern of Bragg contour pairs due to lattice distortions near a large precipitate. This particular example is of a T-phase precipitate in Hyduminium 54 (Al + 6wt.% Cu, 0.5wt.% Mn). Foil buckling is produced by annealing

during observation and may be evidence for evaporation from the precipitate.<sup>1</sup> Comparing Figs. 2 and 3(a), it is evident that the axis of high symmetry in Fig. 3(a) is [111]. The strain in a bent foil is approximately  $\frac{t}{2r}$ , where  $t$  is the foil thickness and  $r$  the radius to which the foil is bent. From the projections of grain boundaries and of helical dislocations, it was estimated that  $t \sim 3,000\text{\AA}$ , and values for  $r$  were obtained from the orientation changes identified by inspection using Fig. 2. Hence, the elastic field around the precipitate was constructed, Fig. 3(b). A similar analysis has recently been made<sup>2</sup> for the buckled edges of evaporating  $\text{UO}_{2+x}$  foils.

It may be noted that the construction described in this communication can also be used for indexing Kikuchi lines.

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2. K. H. G. Ashbee, Phil. Mag., 14, 1031 (1966).

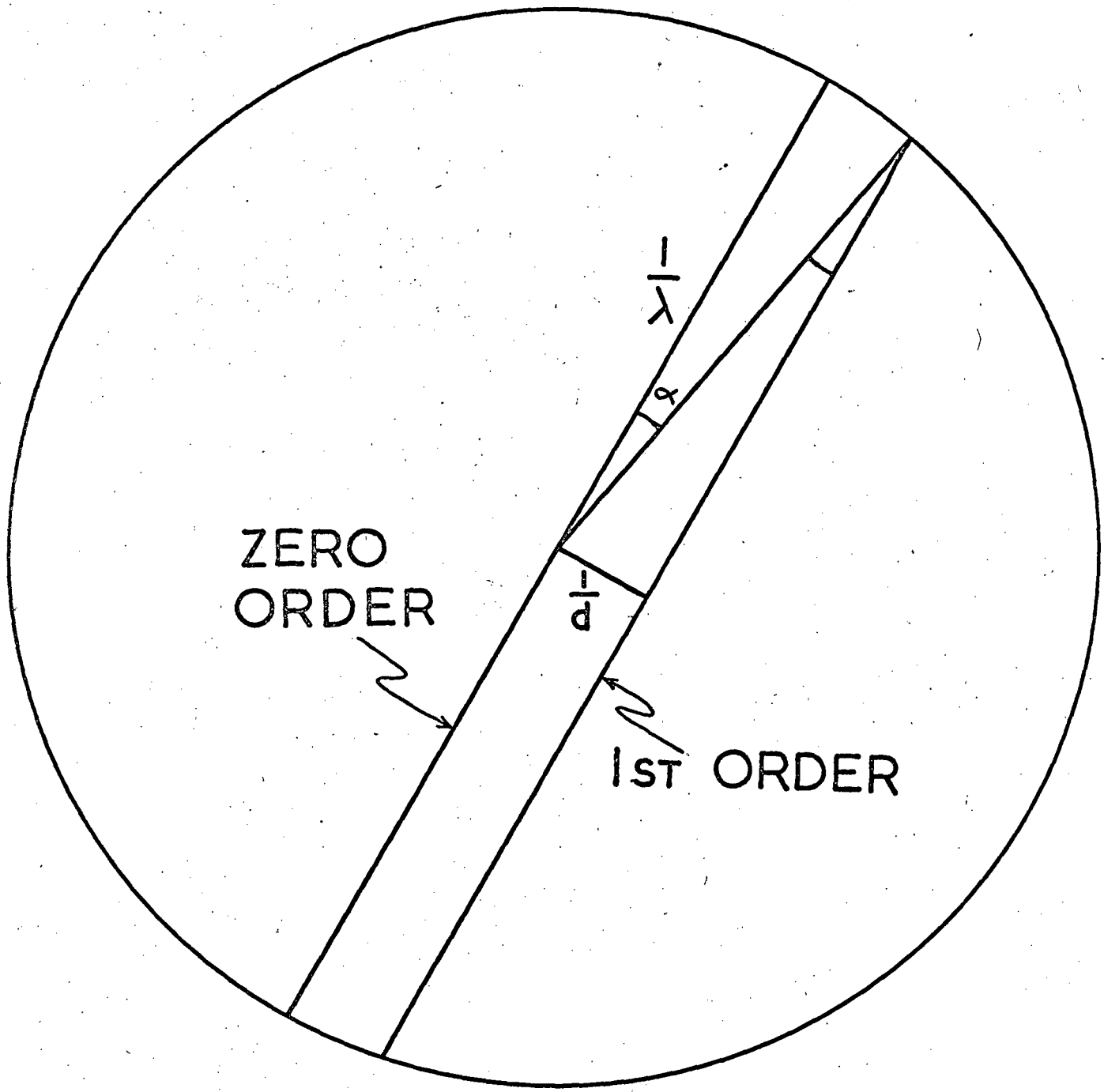


Fig. 1 Section of the Ewald sphere (not to scale).



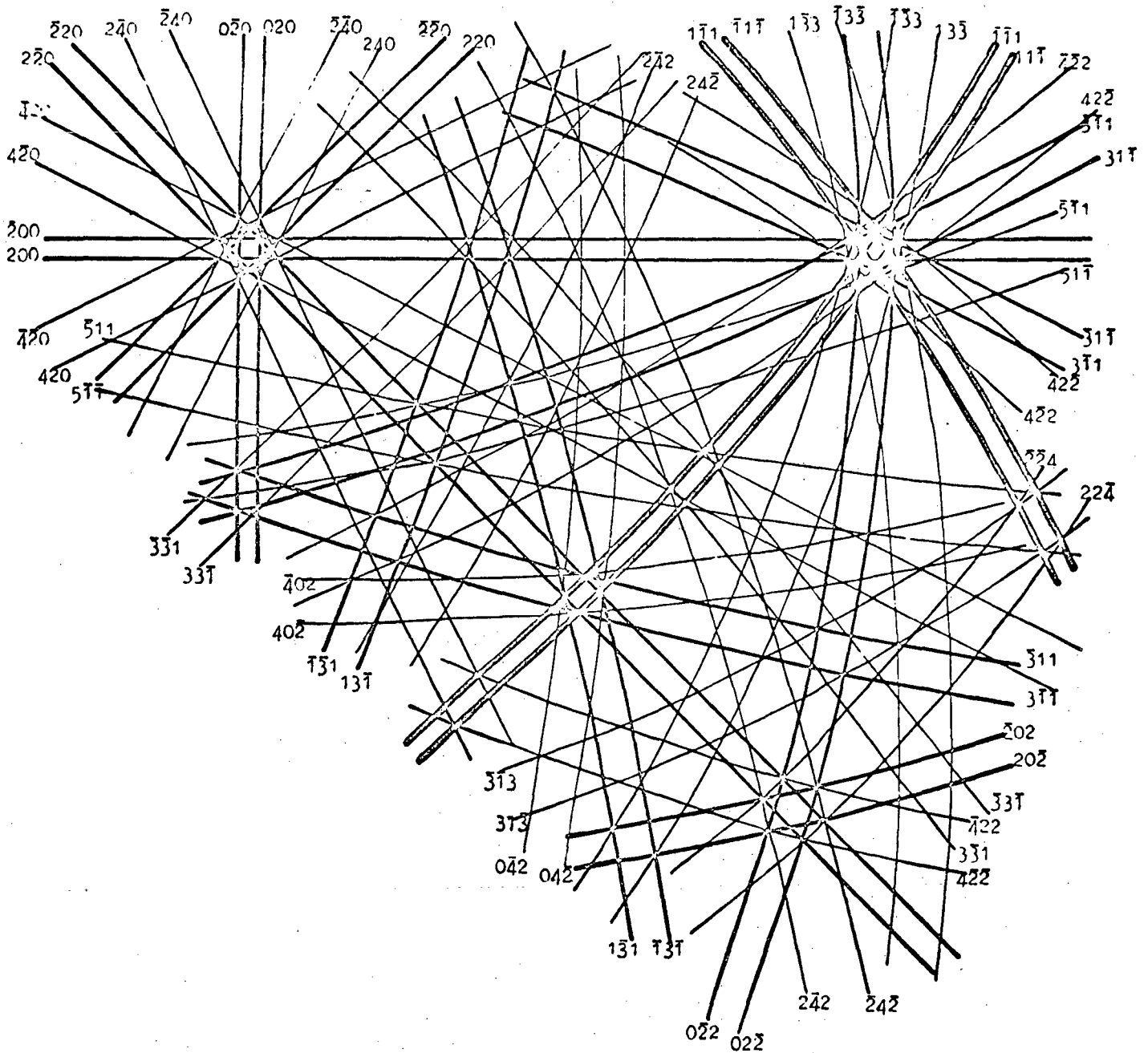
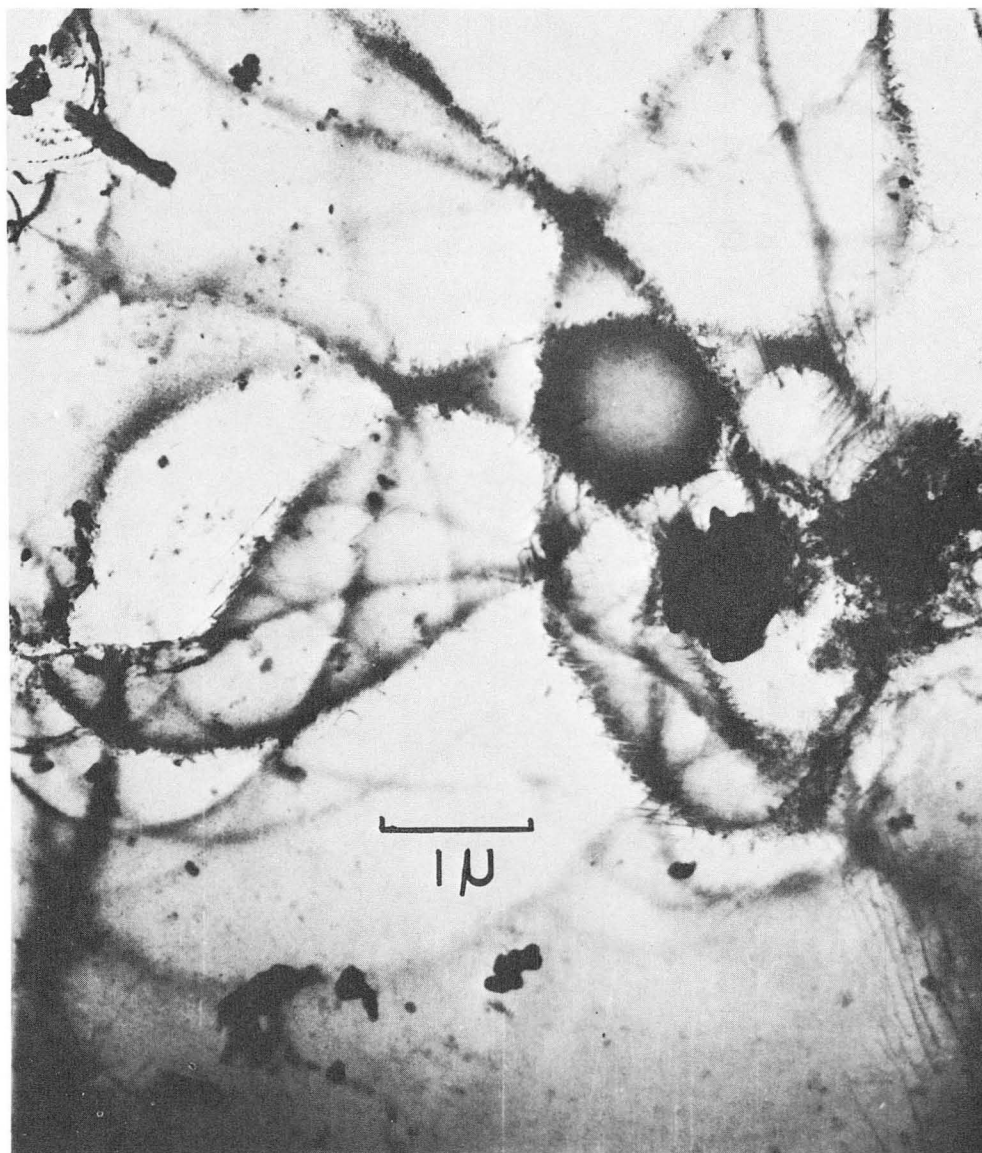


Fig. 2 Stereographic projection of first order Bragg contour pairs for 100 kV electrons in aluminum. It shows the appearance of Bragg contours for all orientations of the incident beam in the unit triangle 001, 011 and 111. All reflecting planes up to line 27 are included, and the relative diffracted intensities expected from structure factor considerations are indicated by variations in line thickness.



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Fig. 3a Bend contours produced around a T-phase precipitate by heating and cooling during observation in the electron microscope.

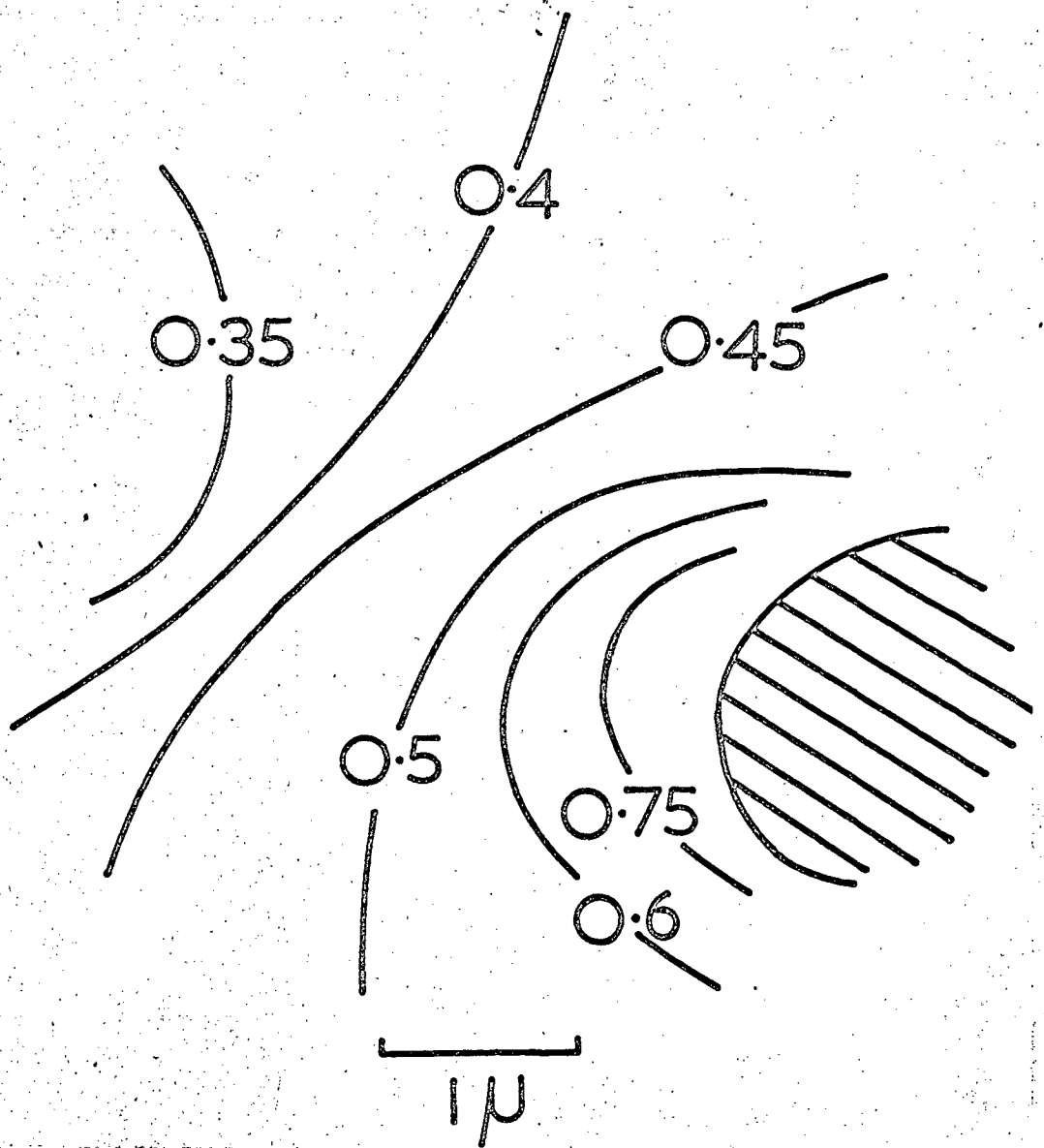


Fig. 3b The elastic field around the T-phase precipitate shown in (a). The contours are labelled in units of strain.

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