

## *A nomogram for the law of direction-cosines.*

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**I**F  $\alpha$ ,  $\beta$ , and  $\gamma$  are the three angles between a line passing through the origin and the three rectangular co-ordinate axes, then the equation connecting them is as follows:

$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1.$$

This is the law of direction-cosines of a line.

Substituting  $(\cos 2\alpha + 1)/2$  for  $\cos^2\alpha$ , &c., we get:

$$\cos 2\alpha + \cos 2\beta + \cos 2\gamma = -1.$$

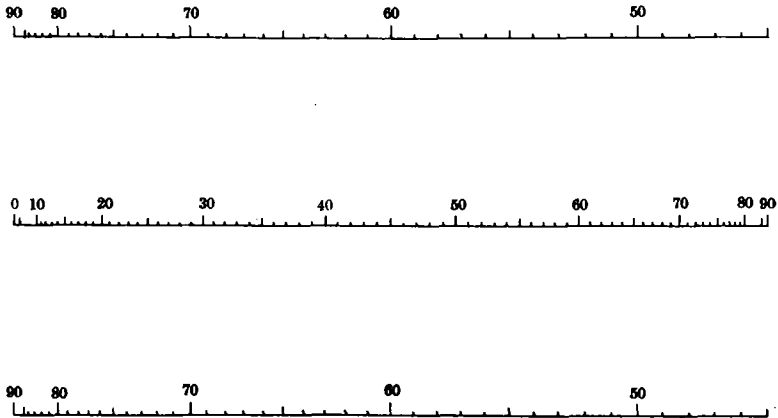


FIG. 1. Nomogram for direction-cosines. (Reduced to  $\frac{1}{2}$ .)

A nomogram for this equation is easily constructed. Three parallel lines of equal length are drawn at equal distances from each other (fig. 1). The first and third lines are graduated with the values of  $\cos 2x$ , from  $x = 45^\circ$  to  $x = 90^\circ$ . The second line is graduated with the values of  $(-1 - \cos 2x)/2$ , from  $x = 0$  to  $x = 90^\circ$ . A straight line drawn across the lines of the nomogram should pass through the three values of angles which will satisfy the equation of direction-cosines.

The nomogram should be drawn on Bristol board and a strip of celluloid with a straight line scratched on its lower surface should be used for the estimation of the angles. The nomogram can be used for a rapid determination of the third angle when the other two are known, or for checking the correctness of the calculated or measured angles.

I have found this nomogram very useful for checking the co-ordinate angles of the principal axes of the optical ellipsoid to a certain crystallographic plane of a

crystal, as measured on the Fedorov stage. The usual procedure of plotting the results of measurements on the Fedorov stage on a piece of tracing-paper placed above a stereographic net, is rather intricate and mistakes of recording are apt to occur. A nomogram of the direction-cosines equation is simple in use and would help to check the figures at a glance. The nomogram can also be used for checking the interfacial angles between the face ( $hkl$ ) and the faces (100), (010), and (001) for crystals with a set of rectangular crystallographic axes.

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*The chemical composition of leucoxene in Cainozoic bauxite  
from Boolarra, Victoria.*

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**D**URING a petrological examination of samples of bauxite from Boolarra, in south Gippsland, Victoria, it was noted that some specimens of the bauxite, which is largely derived from Tertiary olivine-basalt, contained numerous grains of yellow-brown to amber-yellow leucoxene. The leucoxene is clearly pseudomorphous after ilmenite, residual particles of ilmenite being enclosed in many of the leucoxene grains. Most of the leucoxene grains are opaque, but occasional grains are translucent to transparent, though isotropic. Some of them show parallel markings suggestive of cleavage, but probably a residual structure from the replaced ilmenite. In view of the highly aluminous nature of the enclosing rock, there seemed some possibility that this mineral might be the little-known aluminium titanate, xanthitane. It was thought, therefore, that if a pure sample of the mineral could be prepared, a chemical analysis would establish its identity.

When the bauxite was treated with 1 : 1  $H_2SO_4$ , the gibbsite which formed the bulk of it was quickly dissolved, leaving the leucoxene apparently unaltered in the relatively small residue. An attempt to separate the leucoxene from this residue in bromoform was unsuccessful, on account of the fine-grained and flocculent nature of the residue, which consisted chiefly of clay, amorphous silica, and titanium oxide. When, however, the residue was transferred to a Haultain superpanner, it was found that a distinct concentration of the coarser grains of leucoxene could be prepared. The concentrate was contaminated with a considerable amount of ilmenite and partially altered felspar. A sample of 1000 grams of bauxite was then treated in 50 gram lots, first in sulphuric acid, and then on the superpanner. The concentrate obtained was finely granular, and suitable for separation in heavy liquids. Successive treatments in bromoform of specific gravity 2.889 removed all but a small amount of the felspar from the concentrate, which was then returned to the superpanner. Successive treatments were made on the superpanner, until no more ilmenite could be separated. Microscopic examination revealed that ilmenite was still present in moderate