Philosophical Magazine Series 5

ISSN: 1941-5982 (Print) 1941-5990 (Online) Journal homepage: <http://www.tandfonline.com/loi/tphm16>

On the reflection of polarized light

M. Croullebois

To cite this article: M. Croullebois (1877) On the reflection of polarized light, Philosophical Magazine Series 5, 3:19, 397-398, DOI: [10.1080/14786447708639259](https://doi.org/10.1080/14786447708639259)

To link to this article: <http://dx.doi.org/10.1080/14786447708639259>

Published online: 27 Jul 2009.

Submit your article to this journal [↗](#)

Article views: 4

View related articles [↗](#)

ON THE REFLECTION OF POLARIZED LIGHT.

BY M. CROULLEBOIS.

Among the fringes the discovery of which we owe to Mr. Airy there is one, called *courbe en semelle* by M. Billet, remarkable for the instability of its form and orientation, and therefore very appropriate to serve as a characteristic. I purpose to show the advantage that may be derived from the study of this curve in order to ascertain:—1, the physical constitution of a mirror (that is to say, its *positive*, *neutral*, or *negative* nature); 2, the value of the angle of maximum polarization (first constant); 3, the azimuth of restored polarization (second constant).

To obtain this fringe Jamin's apparatus is used, in the ordinary manner, but substituting for the compensator a convergent system formed by a combination of a lens and a perpendicular spar of several millims. thickness. It is, besides, advisable to make use of the homogeneous light of salted alcohol. The mirror giving all the states of ellipticity, the calculation of the isochromatic curves must be effected in a very general case.

Suppose two axes traced in a plane perpendicular to the reflected ray:—the one horizontal, OX, lying in the first azimuth (the plane of incidence); the other vertical, OY. Let OP=1 be the initial vibration, having its direction in the upper right-hand quadrant; and let α , β , γ be the angles formed respectively with OX by the vibration OP, by the principal section of the plate, and by that of the polariscope. The definitive extraordinary image is formed of four components, of which the amplitudes and phases are:—

$$A = \cos \sigma \cos \beta \cos (\gamma - \beta), \phi + E;$$

$$B = \sin \sigma \sin \beta \cos (\gamma - \beta), \phi' + E;$$

$$C = \sin \sigma \cos \beta \sin (\gamma - \beta), \phi' + O;$$

$$D = -\cos \sigma \sin \beta \sin (\gamma - \beta), \phi + O.$$

ϕ and ϕ' designate the phases introduced by reflection, O and E those of the two rays in the spar. In addition, we have put

$$h \cos \alpha = \cos \sigma, \quad k \sin \alpha = \sin \sigma.$$

To calculate the intensity I of the image, we further put

$$\phi - \phi' = \delta, \quad O - E = \delta',$$

and we find the following value—

$$I = (\Sigma A \cos \xi)^2 + (\Sigma A \sin \xi)^2.$$

The isochromatic curves are given by the equation

$$\frac{dI}{d\delta'} = 0,$$

which, rendered explicit, gives

$$\tan \delta' = \frac{-\sin 2\sigma \sin \delta}{\cos 2\sigma \sin 2\beta - \sin 2\sigma \cos 2\beta \cos \delta} = \tan 2\pi\rho^2,$$

ρ being proportional to the distance from the centre of the field to

the point where the luminous ray strikes the retina. Such is the polar equation of the sole-curved fringe (*frange en semelle*).

This fringe has two axes of symmetry of unequal length. The shorter axis is given, in orientation and in length, by the two formulæ:—

$$\tan \beta = -\frac{1}{\tan 2\sigma \cos \delta},$$

$$\tan 2\pi\rho^2 = \frac{\sin 2\sigma \sin \delta}{\sqrt{1 - \sin^2 2\sigma \sin^2 \delta}}.$$

Hence the following consequences:—

1. If $\delta > 0$ (that is, if the mirror is *positive*), the minor axis is oriented in the upper right-hand quadrant.

2. If $\delta < 0$ (that is, if the mirror is *negative*), the same axis is oriented in the upper left-hand quadrant.

3. If $\delta = 0$ (that is, if the mirror is *neutral*), the minor axis vanishes.

4. If $\delta = \pm \frac{\pi}{2}$ (that is to say, under the principal incidence), the minor axis remains oriented at 45° , whatever may be the orientation of the initial vibration.

5. Under this incidence, when the polarizer is rotated, Airy's fringes become transformed into Dove's rings. Let α be the azimuth obtained; it is that of the restored polarization, connected with the factors of alteration of the amplitudes by the formula $\tan \alpha = \frac{h}{k}$.

This method is convenient for the study of reflection in general and also of the laws of Cauchy and Jamin; moreover it is delicate. Indeed, if you employ ordinary glass as the mirror, and observe under an incidence near the polarization-angle, you will recognize that the extremities of the minor axis have an appreciable deviation; and yet the elliptical polarization is so little evident that it escaped Fresnel.

An interesting experiment consists in arranging in succession three mirrors—of *steel*, of *alum*, and of *fluorine*. The first and the third, being one positive, the other negative, present two contrasting positions of the fringe *en semelle*; the second, being neutral, offers the transitory phenomenon of conserved rectilinear polarization.—*Comptes Rendus de l'Académie des Sciences*, March 26, 1877, tome lxxxiv. pp. 604–606.

NOTE ON MOLECULAR VOLUMES. BY F. W. CLARKE, S.B.,
PROFESSOR OF PHYSICS AND CHEMISTRY.

Several years ago, in a series of papers upon atomic or molecular volumes, I pointed out some curious multiple relations connecting both elements and compounds*. For example, I found that a simple relation of this kind connected the alkaline metals with each other;

* Silliman's American Journal, March and May, 1869; September, 1870.