

further in two Memoirs presented in 1822. Its import is very curious. The undulations which, coming from a distant centre, fall upon such a medium as we have described, are, it appears from the principles of mechanics, propagated in a manner quite different from anything which had been anticipated. The "surface of the waves" (that is, the surface which would bound undulations diverging from a point), is a very complex, yet symmetrical curve surface; which, in the case of uniaxal crystals, resolves itself into a sphere and a spheroid; but which, in general, forms a continuous double envelope of the central point to which it belongs, intersecting itself, and returning into itself. The directions of the rays are determined by this curve surface in biaxal crystals, as in uniaxal crystals they are determined by the sphere and the spheroid; and the result is, that in biaxal crystals, *both* rays suffer *extraordinary* refraction according to determinate laws. And the positions of the planes of polarization of the two rays follow from the same investigation; the plane of polarization in every case being supposed to be that which is perpendicular to the transverse vibrations. Now it appeared that the polarization of the two rays, as determined by Fresnel's theory, would be in directions, not indeed exactly accordant with the law deduced by M. Biot from experiment, but deviating so little from those directions, that there could be small doubt that the empirical formula was wrong, and the theoretical one right.

The theory was further confirmed by an experiment showing that, in a biaxal crystal (topaz), neither of the rays was refracted according to the ordinary law, though it had hitherto been supposed that one of them was so; a natural inaccuracy, since the error was small.¹¹ Thus this beautiful theory corrected, while it explained, the best of the observations which had previously been made; and offered itself to mathematicians with an almost irresistible power of conviction. The explanation of laws so strange and diverse as those of double refraction and polarization, by the same general and symmetrical theory, could not result from anything but the truth of the theory.

"Long," says Fresnel,¹² "before I had conceived this theory, I had convinced myself, by a pure contemplation of the facts, that it was not possible to discover the true explanation of double refraction, without explaining, at the same time, the phenomena of polarization, which always goes along with it; and accordingly, it was after having found

¹ *An. Ch.* xxviii. p. 264.

¹² *Sur la Double Réf., Mém. Inst.* 1826, p. 174.