

Young's first published statement of the doctrine of transverse vibrations was given in the explanation of the phenomena of dipolarization, of which we shall have to speak in the next Section. But the primary and immense value of this conception, as a step in the progress of the undulatory theory, was the connexion which it established between polarization and double refraction; for it held forth a promise of accounting for polarization, if any conditions could be found which might determine what was the direction of the transverse vibrations. The analysis of these conditions is, in a great measure, the work of Fresnel; a task performed with profound philosophical sagacity and great mathematical skill.

Since the double refraction of uniaxal crystals could be explained by undulations of the form of a spheroid, it was perhaps not difficult to conjecture that the undulations of biaxal crystals would be accounted for by undulations of the form of an ellipsoid, which differs from the spheroid in having its three axes unequal, instead of two only; and consequently has that very relation to the other, in respect of symmetry, which the crystalline and optical phenomena have. Or, again, instead of supposing two different degrees of elasticity in different directions, we may suppose three such different degrees in directions at right angles to each other. This kind of generalization was tolerably obvious to a practised mathematician.

But what shall call into play all these elasticities at once, and produce waves governed by each of them? And what shall explain the different polarization of the rays which these separate waves carry with them? These were difficult questions, to the solution of which mathematical calculation had hitherto been unable to offer any aid.

It was here that the conception of transverse vibrations came in, like a beam of sunlight, to disclose the possibility of a mechanical connexion of all these facts. If transverse vibrations, travelling through a uniform medium, come to a medium not uniform, but constituted so that the elasticity shall be different in different directions, in the manner we have described, what will be the course and condition of the waves in the second medium? Will the effects of such waves agree with the phenomena of doubly-refracted light in biaxal crystals? Here was a problem, striking to the mathematician for its generality and difficulty, and of deep interest to the physical philosopher, because the fate of a great theory depended upon its solution.

The solution, obtained by great mathematical skill, was laid before the French Institute by Fresnel in November, 1821, and was carried