four internal reflections instead of two; two of the four taking place when the surface of the glass was dry, and two when it was wet. The rhomb was made; and when all the points of reflection were dry, the light was not circularly polarized; when two points were wet, the light was circularly polarized; and when all four were wet, it was not circularly polarized.]

3. *Elliptical Polarization in Quartz.*—We now come to one of the few additions to Fresnel's theory which have been shown to be necessary. He had accounted fully for the colors produced by the rays which travel *along the axis* of quartz crystals; and thus, for the colors and changes of the central spot which is produced when polarized light passes through a transverse plate of such crystals. But this central spot is surrounded by rings of colors. How is the theory to be extended to these?

This extension has been successfully made by Professor Airy.[10] His hypothesis is, that as rays passing along the axis of a quartz crystal are circularly polarized, rays which are oblique to the axis are elliptically polarized, the amount of ellipticity depending, in some unknown manner, upon the obliquity; and that each ray is separated by double refraction into two rays polarized elliptically; the one right-handed, the other left-handed. By means of these suppositions, he not only was enabled to account for the simple phenomena of single plates of quartz; but for many most complex and intricate appearances which arise from the superposition of two plates, and which at first sight might appear to defy all attempts to reduce them to law and symmetry; such as spirals, curves approaching to a square form, curves broken in four places. " I can hardly imagine," he says,[11] very naturally, " that any other supposition would represent the phenomena to such extreme accuracy. I am not so much struck with the accounting for the continued dilatation of circles, and the general representation of the forms of spirals, as with the explanations of the minute deviations from symmetry; as when circles become almost square, and crosses are inclined to the plane of polarization. And I believe that any one who shall follow my investigation, and imitate my experiments, will be surprised at their perfect agreement."

4. *Differential Equations of Elliptical Polarization.*—Although circular and elliptical polarization can be clearly conceived, and their existence, it would seem, irresistibly established by the phenomena, it

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[10] *Camb. Trans.* iv. p. 83, &c.   [11] *Camb. Trans.* iv. p. 122.