that he could account for the phenomena of quartz, already observed by M. Arago, as we have noticed in Chap. ix., by supposing two circularly-polarized rays to pass, with different velocities, along the axis. The curious succession of colors, following each other in right-handed or left-handed circular order, of which we have already spoken, might thus be hypothetically explained.

But was this hypothesis of two circularly-polarized rays, travelling along the axis of such crystals, to be received, merely because it accounted for the phenomena? Fresnel's ingenuity again enabled him to avoid such a defect in theorizing. If there were two such rays, they might be visibly separated[7] by the same artifice, of a pile of prisms properly achromatized, which he had used for compressed glass. The result was, that he did obtain a visible separation of the rays; and this result has since been confirmed by others, for instance, Professor Airy.[8] The rays were found to be in all respects identical with the circularly-polarized rays produced by the internal reflections in Fresnel's rhomb. This kind of double refraction gave a hypothetical explanation of the laws which M. Biot had obtained for the phenomena of this class; for example,[9] the rule, that the deviation of the plane of polarization of the emergent ray is inversely as the square of the length of an undulation for each kind of rays. And thus the phenomena produced by light passing along the axis of quartz were reduced into complete conformity with the theory.

[2nd Ed.] [I believe, however, Fresnel did not deduce the phenomenon from the mathematical formula, without the previous suggestion of experiment. He *observed* appearances which implied a difference of retardation in the two differently-polarized rays at total reflection; as Sir D. Brewster observed in reflection of metals phenomena having a like character. The general fact being observed, Fresnel used the theory to discover the law of this retardation, and to determine a construction in which, one ray being a quarter of an undulation retarded more than the other, circular polarization would be produced. And this anticipation was verified by the construction of his *rhomb*.

As a still more curious verification of this law, another of Fresnel's experiments may be mentioned. He found the proper angles for a circularly-polarizing glass rhomb on the supposition that there were

---

[7] *Bull. des Sc.* 1822, p. 193. [8] *Cambridge Trans.* iv. p. 80.
[9] *Bull. des Sc.* 1822, p. 197.