hedral crystals are usually very smooth and transparent, and often of considerable size; and it was observed, on looking through them, that all objects appeared double. The phenomena, even as early as 1669, had been considered so curious, that Erasmus Bartholin published a work upon them at Copenhagen,[1] (*Experimenta Crystalli Islandici*, Hafniæ, 1669.) He analysed the phenomena into their laws, so far as to discover that one of the two images was produced by refraction after the usual rule, and the other by an unusual refraction. This latter refraction Bartholin found to vary in different positions; to be regulated by a line parallel to the sides of the rhombohedron; and to be greatest in the direction of a line bisecting two of the angles of the rhombic face of the crystal.

These rules were exact as far as they went; and when we consider how geometrically complex the law is, which really regulates the unusual or extraordinary refraction;—that Newton altogether mistook it, and that it was not verified till the experiments of Haüy and Wollaston in our own time;—we might expect that it would not be soon or easily detected. But Huyghens possessed a key to the secret, in the theory, which he had devised, of the propagation of light by undulations, and which he conceived with perfect distinctness and correctness, so far as its application to these phenomena is concerned. Hence he was enabled to lay down the law of the phenomena (the only part of his discovery which we have here to consider), with a precision and success which excited deserved admiration, when the subject, at a much later period, regained its due share of attention. His Treatise was written[2] in 1678, but not published till 1690.

The laws of the *ordinary* and the *extraordinary* refraction in Iceland spar are related to each other; they are, in fact, similar constructions, made, in the one case, by means of an imaginary sphere, in the other, by means of a spheroid; the spheroid being of such oblateness as to suit the rhombohedral form of the crystal, and the axis of the spheroid being the axis of symmetry of the crystal. Huyghens followed this general conception into particular positions and conditions; and thus obtained rules, which he compared with observation, for cutting the crystal and transmitting the rays in various manners. "I have examined in detail," says he,[3] "the properties of the extraordi-

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[1] Priestley's *Optics*, p. 550. [2] See his *Traité de la Lumière*. Preface.

[3] See Maseres's *Tracts on Optics*, p. 250; or Huyghens, *Tr. sur la Lum.* ch. v. Art. 43.