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Newton's
authority
on the
side of the
emission
theory,

as that theory failed for a long time to explain the apparently fundamental fact, viz., that light travels in straight lines, accompanied by well-marked shadows. The contrary view, according to which light is a tremor propagated like sound, was unable to explain the existence of clearly marked shadows. And so it came about that Newton, to whom both theories were quite familiar, and to whom we owe great discoveries telling severally in favour of each of these theories, in the end threw the weight of his authority into the scale of the corpuscular or emission theory. For many this was quite sufficient to suppress for a long time all claims which the tremor or wave theory put forward, the fact being forgotten or overlooked that Newton himself had pronounced the pure emission theory to be insufficient, and had modified and complicated it by

tion to crystallography, it became a desideratum to reach the geometrical conception of the wave-surface by purely geometrical methods. This has been done in an admirable treatise entitled 'The Optical Indicatrix,' by Mr L. Fletcher. He has shown that the construction of the ray, a conception easily defined geometrically, gives an easier approach than the construction of the wave, which introduces physically doubtful definitions; and he demonstrates how "a simple generalisation, involving no reference either to the constitution of the luminiferous ether or to the nature of the physical change involved in the transmission of light," will lead to the ray surface (p. 18). For his purpose he starts from a surface of reference, which in singly refractive substance is a sphere, in uniaxial crystals a

spheroid, and by inference in biaxial crystals an ellipsoid with three unequal axes. This beautiful construction was arrived at, as the author tells us, before the detailed history of Fresnel's theory had come to his notice. It is now known through Verdet, one of the editors of Fresnel's 'Works' (1868), that Fresnel arrived at his wave-surface by a purely geometrical generalisation of Huygens' construction, and that the conception of the ether was subsequently fixed so as to allow the wave-surface to be deduced therefrom (p. 24); surely an interesting case in the history of scientific thought. As to the insufficiency of purely geometrical optics for explaining the phenomena connected with optical instruments, see Czapski, 'Theorie der optischen Instrumente,' Breslau, 1893, p. 2.