CHRISTIAAN HUYGHENS AND THE WAVE THEORY
OF LIGHT

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1. INTRODUCTION

The world, as we perceive it, is pictured for us by the rays of light which proceed from each point of the objects around us and form images of these objects on the retina of our eyes—a statement which needs no amendment even when the aid of optical instruments such as the telescope or the microscope is invoked to enlarge our powers of vision. To put it a little differently, the principles of geometrical optics suffice to describe the behaviour of light as commonly experienced, viz., that the rays of light are propagated in straight lines; that the angles of incidence and of reflection are equal; and that in refraction the rays of light are bent according to the law of sines. In his celebrated Traite de la Lumiere published in the year 1690, Christiaan Huyghens showed that these facts of experience are consistent with the hypothesis that light is in the nature of wave-motion propagated through space and can indeed be satisfactorily explained on the basis of that hypothesis. The treatise of Huyghens contains much other material of importance; a perusal of it leaves on the mind of the reader the impression that it is a masterpiece of scientific thought and exposition which possesses an enduring value and interest.

In connection with some experimental investigations on the diffraction of light undertaken by the present author—the results of which will soon be published in these Proceedings—the need was felt for a careful study of the original ideas of Huyghens. The task was made much easier by using the literal translation of his treatise from the original French into English by Sylvanus P. Thompson published by the Chicago University Press in the year 1912. The results of the study were surprising; it emerged that the ideas of Huyghens were not fully or even correctly understood by later writers. This misunderstanding has had some far-reaching consequences. Especially in regard to the so-called “Principle of Huyghens” do we find that later writers have chosen a path for which there is no warrant in the writings of Huyghens. In view of these circumstances, it has appeared desirable to put forward a clear exposition of the ideas of Huyghens and supplement the same
by a critical examination of the writings of later authors which claim to be based on those ideas.

2. THE NATURE OF LIGHT

In the first few pages of his book Huyghens set out the considerations which led him to infer that light is in the nature of a movement which spreads into space in all directions from a luminous source. He remarks that the terrestrial sources which are observed to emit light, such as fire or flame evidently contain bodies in rapid motion. Then again, when sunlight is collected by a concave mirror and concentrated on material objects, it has the same effects as fire, viz., it disunites the particles of those objects. It is therefore natural to suppose that light is itself some kind of motion and that the sensation of light is excited when such movement is communicated to the nerves at the back of the human eye. Huyghens also remarks on the extreme speed with which light spreads on every side and on the circumstance that when light comes from different regions, even from those directly opposite each other, the rays traverse one another without hindrance. The facts indicate that light is a movement transmitted through space and not a transport of matter which reaches the eye from the source of light.

To account for the very high velocity of propagation of light—known from the observations of Römer on the eclipses of Jupiter’s satellites—and the fact that light can pass through empty space, Huyghens proposed a physical picture of the ætherial medium which could explain its power to transmit waves with such high velocity. He suggested that the æther of space consists of an immense number of extremely small and extremely hard spherical particles in close contact with each other. Experiments on the percussion of elastic solid spheres on each other show that a medium of the nature postulated could propagate waves simultaneously in all directions with high velocity and in such manner that waves travelling in different directions at one and the same time would not hinder each other’s progress. Huyghens further recognized that every luminous object would necessarily contain an immense number of centres emitting light and that from each of such centres thousands of waves might emerge in the smallest imaginable time; he pointed out that these considerations would make it easier to understand, why in spite of the enfeeblement of the individual waves by their spread through immense distances, the light of the distant stars continues to be perceptible to human eyes.

3. THE RECTILINEAR PROPAGATION OF LIGHT

The mechanical model of the æther proposed by Huyghens to account for the propagation of waves of light through it also enabled him to give a