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ELEMENTS

OF

OPTICS.

BY

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PREFACE.

The following Elementary Treatise has been compiled, at the desire of the Board of Trinity College, for the use of the junior Students in the University. It is, in a great measure, an abridgment of the Author's *Treatise on Light and Vision;* but with such alterations of form and method as seemed necessary for its present purpose. Experience proves that the same treatise cannot be adapted, with advantage, to the wants both of the general Student, and of the Candidate for Honors. Accordingly, in the selection of the materials for the present volume, which is intended for the former, all but the more essential and elementary portions of the science have been excluded; while, at the same time, the attempt has been made to present these under the simplest form consistent with demonstrative exactness. How far the writer has succeeded in this attempt—one of admitted difficulty—must be left to the experience of the Tutors.

The writer has to express his acknowledgments to the Board, for the assistance afforded by them to the present publication.

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ELEMENTS OF OPTICS.

CHAPTER I.

OF DIRECT LIGHT.

1. DEF. Any body which excites in us the sensation of light is termed *luminous*.

2. The light of all luminous bodies emanates from them in all directions.

This is evident from the fact, that such bodies are visible in whatever position the eye may be with respect to them, if no obstacle be interposed. Thus the light of a candle is seen in all parts of a room, when there is no opaque body between the eye and the flame; and the light of the sun and stars is diffused throughout the celestial spaces.

3. Light is propagated with finite velocity.

This discovery was made by the Danish astronomer, Olaus Roemer, while observing some irregularities in the eclipses of Jupiter's satellites, in the year 1676. It was observed that when Jupiter was in opposition, and therefore nearest to the earth, the eclipses happened *earlier* than they should according to the astronomical tables; while, when Jupiter was in conjunction, and therefore farthest, they happened *later*. The difference between the computed and observed times Roemer justly ascribed to the time taken by the light in traversing the radius of the earth's orbit. This time is found to be $8^m 13^s$; and consequently the velocity of light is such that it traverses 192,500 miles in a second of time.

The observation of the fixed stars is the result of the velocity of their light, combined with that of the earth in its orbit, and its amount depends on the ratio of these velocities. Conversely, the amount of aberration being known by observation, the velocity of light is determined relatively to that of the earth. The velocity thus deduced agrees with that derived from the observation of the eclipses of Jupiter's satellites; thus proving that the direct light of the fixed stars, and the reflected light of the satellites, travel with the same velocity.

4. Light consists of parts, which are separable and independent.

For any portion of light may be stopped by an opaque obstacle, and the rest suffered to pass; and the latter part is found to retain all the properties which it possessed before the separation.

5. Def. The smallest portion of light which can be intercepted, or allowed to pass, is called *a ray*.

6. Def. Whatever affords a passage to the rays of light is called *a medium*.

7. Def. The light which is propagated without interruption, in the same medium, is said to be *direct*.

8. When light encounters the surface of a new medium, it undergoes several modifications, of which the three following are the chief:

I. On meeting the surface of the new medium, the whole, or a portion of the light, is turned back into the medium from which it came. This portion is said to be *reflected*.

II. A portion of the light, in general, enters the new medium, pursuing there an altered course. This portion is said to be *refracted*.

III. A portion of the light which enters the medium is arrested in its progress. This is said to be *absorbed*.

9. In the same homogeneous medium, light is propagated *in right lines.*

The truth of this fundamental law is established by many familiar facts. An object cannot be seen when an opaque body is interposed in the right line connecting it with the eye. Thus if three opaque discs be perforated each with a small aperture, and the eye be placed before the nearest, and the light of a candle behind the farthest, that light will be visible, or not, according as the apertures are, or are not, in the same right line.

The truth of this law may be more obviously evinced by admitting a small beam of the sun's light into a darkened chamber, through an aperture in the window; the particles of dust which float in the air reflecting the beam, and exhibiting its rectilinear form. The same thing is also shown by the shadows of bodies, which are always bounded by right lines.

10. Def. A medium in which no light is absorbed or lost is said to be *perfectly transparent.*

11. In a perfectly transparent medium, the intensity of the light proceeding from a luminous point varies inversely as the square of the distance.

For the intensity of the light received upon any spherical surface whose centre is the luminous point, is as the quantity of the light directly, and inversely as the space over which it is diffused. But none of the light being lost, the quantity of light received upon any spherical surface is the same as that emitted, and is, therefore, constant for a given luminous source. And the space of diffusion, or the area of the spherical surface, is as the square of its radius. Hence the intensity of the light is inversely as the square of the radius, i. e., inversely as the square of the distance.

Let the light be supposed to emanate from the points of an uniformly luminous surface, which we shall suppose to be a small portion of a sphere. Then the quantity of light emitted is proportional to the quantity emitted by a single point, and the number of points (or area) conjointly. Hence if A denote the area of the luminous surface, and I the quantity emitted from a single