Understanding Optical Diffraction and Interference Patterns through a Historical Perspective

PH2255 Final Report

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Abstract

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Contents

1 Introduction

To fully understand an optical theory of light—and to understand why diffraction and interference experiments are so important to ir—it is helpful to understand the history of how different theories arose. Today, we have a very good understanding of light as an electromagnetic interaction between the magnetic and electric fields, enabled by Photons—the EM force carrier. It is common knowledge, even in popular culture, that light exhibits both wave-like and particle-like behaviour. However, in the 17^{th} and 18^{th}, the picture wasn't so clear.

1.1 A Brief Historical Overview

While ancient philosiphers—such as Pythagoras, Plato, and Asristotle—began the development of theories of light in the Greek Classical period, progress rapidly accelerated in the seventeenth century with the advent of the refracting telescope. As Galileo and Kepler developed their respective telescope systems in the early 1600s, Snel[1] re-discovered Sahl's law of refraction. While these laws did accurately describe light moving through media of varying refractive indices, they rely on the assumption that light travels the path which takes the least time. This assumption can be disproven, such as with a spherical mirror, and as such cannot define a fundemental theory of light

Nonetheless, Snel's law laid the foundations for a rapid development of modern optics. In 1665, at the Royal Society in London, Hooke was one of the first to study the field known today as diffraction and interference, the subject of this report. In his book *Micrographia* [Hooke(1665)], the idea of light being vibrations in a medium was first proposed:

> *"...this motion is propagated every way with equal velocity, whence necessarily every pulse or vibration of the luminous body will generate a Sphere, which will continually increase, and grow bigger, just after the same manner (though indefinitely swifter) as the waves or rings on the surface of the water do swell into bigger and bigger circles about a point of it, where by the sinking of a Stone the motion was begun, whence it necessarily follows, that all the parts of these Spheres undulated through a Homogeneous medium cut the Rays at right angles."* —[Hooke(1665)]

Thus began the wave theory of light.

1.2 Newton's Particle Theory

At the same time, Newton was making his own advances in the field of optics. In his 1704 paper *Opticks* [Newton(1704)], he proposed a particle theory of light—initially set forward by Descartes—where light rays are comprised of small discrete particles named "corpuscules", hence its name *the corpuscular theory.* His main motivation for choosing a particle theory was the apparent inability of a wave theory to explain rectilinear propagation[2].

Despite the corpuscular theory's ability to describe both rectilinear propagation and polarisation (whereas wave theories ignored the latter), it relied on assumptions that modern physicists would resoundly reject - that the speed of light is infinite, but also that it sped up in denser media.

[1] Willebrord Snellius, usually known as Snell

[2] The propensity of light to travel in a straight line in the absence of any interference.

1.3 Huygens' Wave Theory

1.4 Developing an Optical Theory

2 Experimental Setup

3 Experimental Method

4 Results

5 Data Analysis

6 Summary of Findings

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$$\text{equation} \tag{1}$$

Figure 1: PNG

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Table 1: Caption.

A Appendix

A.1 Bibliography

References

[Hooke(1665)] Robert Hooke. *Micrographia: or, Some Physiological Descriptions of Minute Bodies made by Magnifying Glasses*. The Royal Society, London, 1665. URL `http://www.gutenberg.org/files/15491/15491-h/15491-h.htm`. Gutenberg eBook 15491.

[Newton(1704)] Isaac Newton. *Opticks: or, a Treatise of the Reflections, Refractions, Inflections, and Colours of Light*. William Innys, London, 1704. URL `https://www.gutenberg.org/files/33504/33504-h/33504-h.htm`. Gutenberg eBook 33504.

A.2 Python Code