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Conflict About The Nature Of Light

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***Abstract*—In eighteenth century, there was a conflict about 'Nature of Light'. There was a vital question raised in the scientific community that 'what is the light made up of ?' Sir Isaac Newton proposed that light is made from small particles called corpuscles but Christian Huygens proposed that light was made up of waves and not particles. Newton and Huygens' theories sparked a big debate on the nature of light. They both deeply studied the light and came up with their theories. Finally, from several experiments, scientists came on conclusion that light consists of both particle nature and wave nature.**

Keywords—Dual Nature of Light; Conflict in Scientific Community; Newton's Particle Theory; Huygens Theory of Wave nature of light.

1. Introduction

Since the existence of human civilization, light is a well-known phenomenon. The concept of light, at the early stage of human life, was just limited to a form of energy which was a core component for human survival. The era of scientific reasoning changed many beliefs of various natural phenomena that people were integrated with in their daily life. Among these, the theoretical concept of light was also unknown in the field of science. In the time around 2500 years ago, one of the scientists Empedocles assumed and stated that every material was composed of four elements; fire, air, earth and water. At that time, he also believed that the visibility is possible due to the fire. This was obviously not true, because from this theory, one could see during the night just as well as during the day. Similarly, in the time 2300 years ago, another scientist Euclid wrote a book related to the properties of light. First he assumed that light always travels in straight path. Assuming this, he proved different laws about reflection and refraction phenomena. About 2060 years ago, Roman scientist Lucretius also explained about the light whose source is the Sun. He also explained about the particle nature of light but this theory was not accepted. In 200 AD, the mathematician Ptolemy also described about the properties of refraction of light in his book. Many such postulates dwelled around the minds of physicists and philosophers over hundreds of years, but all these theories were just the building blocks for the true concept of light.

In 1637, René Descartes explained by publishing a theory about the reflection of light. He believed that light travels slower in less dense medium on comparing with high dense medium as the sound waves. He supported that light has wave nature. Newton in 1678 proposed the corpuscular theory of light which consists of streams of tiny light and perfectly elastic particles called corpuscles. In this theory it is supposed that the various colors are due to different size of corpuscles. In refraction phenomena, the corpuscles were attracted by the particles of the denser medium due to which the speed of light travel in a rarer medium is less than that in the denser medium. The Newton's corpuscular theory was popular among the scientific community in the late sixteen and early seventeen century but this theory could not explain the interferences, diffraction and polarization. So it was over turned by Huygens and Fresnel's through a series of experiments postulating that light was a wave. The young's double slit experiment was one of them. After the Huygens and Fresnel's theory, the physics of light was becoming clearer to the general population. Maxwell further honed the properties of light by describing that light is an electromagnetic wave travelled with the speed of $3x10^8$. His theory was late proved by Hertz. At present, quantum theory of light is what we have that accurately describes light. This theory describes that light is not only a wave but also a particle (i.e. the dual nature of light). Einstein postulated the corpuscular nature of light in his theory of photoelectric effect of light.

2. The Newton's Corpuscular Theory of Light

Initially the scientist Descartes proposed the particle theory of light. He postulated that it consists of small particles and travel in a straight path. So the light has certain energy. Later, Newton developed and proposed the theory in the year 1675, this energy gives sensation in our eyes. The size and mass give the colour of light and follows the different phenomena of light. In denser medium light particles are attracted by particles of the medium and velocity increases and changes the direction. Newton was a great scientist so no one can deny his theory, but after failure of the phenomena of interference,

diffraction and polarization Huygens came to overcome this phenomena.

3. Huygens Wave Theory of Light

Christian Huygens proposed the wave theory and proved the phenomena of interference, diffraction etc. from his assumption. For the propagation of light, he stated that "every point on a wave-front considered as a secondary source and the wave-front after short propagation distance is the result of superposition of all these spherical waves." In 1801, the wave theory became definitely established through the classic experiments of Thomas Young on interference, the light pattern can be seen on the screen as shown in figure 1. Unaware of Young's result, in 1816 Fresnel also supported by giving the mathematical model of propagation of light. Further Poisson, Arago, etc. supported Huygens wave theory. Thus, the young's double slit experiment and Huygens-Fresnel's wave theory of light are considered as the building blocks of wave nature of light.

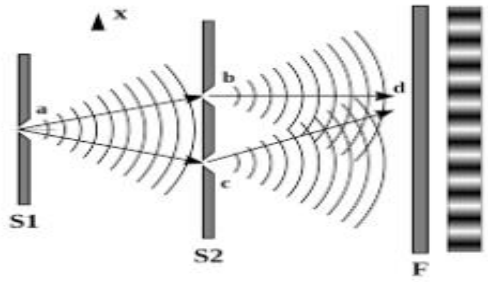

Figure 1: ***The experiment performed by Thomas young in 1801***

4. The Electromagnetic Theory of Light

The electromagnetic theory was first proposed and presented by Maxwell in 1864. He explained about electric field, a magnetic field and light separately. Many other discoveries of the highest and greatest values were made, but the electromagnetic theory of light stands apart as one of the crowning achievements of nineteenth century.

The wave theory, according to which light consists of waves travelling through a medium of some sort rather than a stream of particles was popularized by Huygens, and in many aspects seemed more closely in accord with the experimental results than the corpuscular theory. Newton seems to have been led to reject the wave theory because of the fact that it doesn't appear to bend around the corners of the obstacle as do sound or water waves, but diffraction experiments of Fresnel proved that light does bend around the edges of the body as do other types of waves, thereby proving the wave nature of light. Finally, in 1801 the wave theory became definitely established through the classic experiments of Thomas Young on interference.

Maxwell, inspired from the discovery of Oersted and Michael Faraday, showed that electro-magnetic disturbances, originating at any point in space, should be propagated in all direction with a finite velocity that could be calculated by the means of certain equations he derived. The value of velocity thus calculated came out 3×10^8 m per second. Maxwell went further than this and showed that an oscillating electric charge should give rise to a wave in answering in all essentials to the known properties of light waves; that these waves, consisting of an electric field accompanied by an alternating magnetic field at right angle to it, and hence known as electromagnetic waves. Another very important fact was the evident from Maxwell's equations that the electromagnetic waves are transverse waves which were essential characteristics of light waves which cannot be explained by the Newton's corpuscular theory.

5. Conclusion

There were so many experiments done by so many scientist about the nature of light. Finally, the light follows both the wave nature and particle nature. Maxwell also came in conclusion that light can travel in the direction perpendicular to electric field, perpendicular to magnetic field and perpendicular to both electric and magnetic fields. Later, in 1924, the French physicist Louis De Broglie suggested that every moving particle is associated with a wave which controls the particle in every respect. He then concluded that light consists of dual nature, both wave nature and particle nature.

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