The Failure of Thomas Young's Wave Theory

by Hamid – June 2012

Abstract

I have no intention in this article to argue that in a realistic interpretation of quantum theory (quantum mechanics) light is propagated only in the form of pockets of energy called photons and it is a successful theory, and the only particle physics is able to explain the behavior of nature, or to insist that failure of wave theory is that it failed to explain photo-electric effect, Compton's effect, blackbody radiation … etc. But I am going to show that about two hundred years after *Thomas Young* (1773-1829) published the results of his double-slit experiments, as demonstrated to the *Royal Society of London*, there exist enough information enabling us to prove that *Young's Wave Theory* is far from reality and is inherently wrong. This claim is based on the current level of technology which has paved the way for implementation of new techniques for high precise and accurate experiments and measurements. Consequently, it seems that in this relation a paradigm shift is necessary.

Facts which cannot be explained within the framework of a paradigm initiate a "*paradigm crisis*" followed by "*paradigm debate*" which eventually leads to "*paradigm shift*".

1. What is a Paradigm?

Let us have a look at the following explanation about paradigm which has been translated from a Persian text and clarifies to some extent the issue:

"Each paradigm is a collection of basic and systematic assumptions that, in the passing of life, in an unaware and unselected form takes place in the humans' mind, and leads the process of their cognition of the world. The function of these assumptions is like the function of pores in a filter or the function of a prism; through which our sense-data passes and makes our cognition. When Euclidean geometry, Archimedes' law, particle theory (and wave theory) of light, the principle of class struggle as the driving force of history, and the like, are transformed into a general belief without the need of reasoning; they are counted as a paradigm. Each paradigm may be, in its essence, true or false; but as long as we believe it's true, we base all our knowledge and judgments on that paradigm which is housed in our mind. Paradigms may change or be replaced in the passing of history. With this change, the approach or the way of thinking and the methodology of human cognition will also change. As before *Galileo Galilei (1564-1642)* that the human perception of astronomy was something and thereafter is another thing.

Paradigms come from various sources: philosophical systems, religion and religious beliefs, superstitions, myths, empirical knowledge, repetitive advertising, and the like. Fundamental characteristic of a paradigm is that most people associated with it knowing it as true, without the need of reasoning.**"**

I am personally afraid of any assumption, because even a tiny false assumption could lead to a catastrophe.

2. The Current Dominant Paradigm

Even though the reader may live or be familiar with the current dominant paradigm of wave theory and wave-particle duality, a short review of it is appropriate here. Therefore I have selected two references from the internet for doing this. The first one is an academic reference, and the other one is an ordinary reference.

2.1. The Academic Reference

This reference, which can be regarded as a brief history of particle theory and wave theory of light and also the wave-particle duality, is an article titled**:** "*The Dual Nature of Light as Reflected in the Nobel Archives*"**.** It was originally delivered as an academy lecture; first published 2 December 1999 by Gösta Ekspong, professor of physics Stockholm University, Sweden. Some points mentioned in this article are given below**:**

- ***The Wave-Particle Duality***

  Early in the nineteenth century experiments were suggested and made to show that light is a wave motion. A key figure in this endeavour was Thomas Young, one of the most intelligent and clever scientists ever to live, who studied diffraction and interference of light already in 1803 with results that gave strong support to the wave theory of Christian Huygens as opposed to the particle or corpuscular theory of Isaac Newton. Further contributions were made by many other researchers, among them Augustin Jean Fresnel, who showed that light is a transverse wave.

- ***Evidence for the Particle Nature of Light***

  In physics textbooks two phenomena are usually quoted demonstrating the particle nature of light: 1) the photoelectric effect and 2) the Compton scattering of X-rays.

  In some not so critical texts a third circumstance is erroneously quoted, namely Planck's discovery of energy quanta, which he did in his analysis of heat radiation. The Nobel Committee honoured this monumental discovery by the Physics Prize in 1918, but did not make the mistake to give Planck credit for having discovered the particle nature of light.

- ***Prizes for the Discoveries of the Dual Nature of Matter***

  The dual nature of light has been extended to a similar duality in matter as well. Electrons and atoms were originally considered as corpuscles. In 1929 Prince Louis-Victor de Broglie was awarded the Nobel Prize for Physics for "his discovery of the wave nature of electrons". Experimental proofs were given by Clinton Joseph Davisson, New York, and Sir George Paget Thomson from London. They were jointly awarded the Nobel Physics Prize in 1937. Ever since Erwin Schrödinger in 1925 discovered the nonrelativistic wave equation for the electron wave mechanics has been a valuable tool for the natural sciences. Schrödinger was awarded the Nobel Prize in Physics in 1933.

- ***The Wave-Particle Duality in One and the Same Experiment***

  Experiments with beams of light or of electrons have been made such that both aspects - waves and particles - are observed. For interference to occur it is among other things also necessary for the beam to have available more than one path from source to detector (e.g. a screen). Interference is explained by the wave picture. When the beam intensity is sufficiently low and the detector suitable the impact of particles one by one can be observed. The energy quanta are then localised as if particles in space and time.

This lecture suggests that "*every new physics student therefore has to struggle with the duality problem, allowing the simultaneous existence of both particle and wave concepts and holding that the two are mutually exclusive (as Niels Bohr formulated in his Complementarity Principle of 1927).*"

2.2. The Ordinary Reference

This reference very clearly indicates the existing general idea about particle theory and wave theory, the content of which is almost common in thousands of internet sources. In relation to the subject under discussion, there are two figures in this site that one of

them, Figure 2, shows a sound geometric detail of Young's double-slit pattern which is very useful for our analysis. One paragraph of this document together with the figures are given below:

"*In 1803, English physicist Thomas Young provided strong evidence for Dutch mathematician Christian Huygens' wave theory of light when he published the results of his double-slit experiments (Scheider, pp.217-219). Young repeated earlier experiments with diffraction but continued to pass the diffracted light through two more slits. He argued that if light is composed of particles, then they should all pass through separate holes and create two bright patterns on the other side. If light is composed of waves, however, then it should produce a predictable interference pattern, just as water waves do.*"

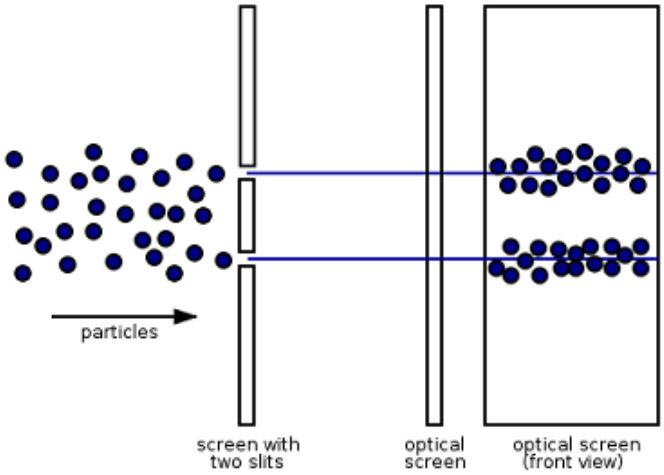


Figure 1- The double-slit experiment with particles

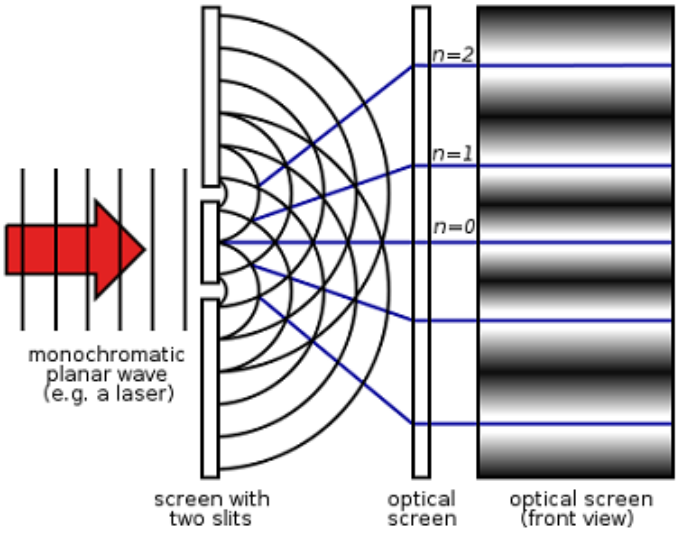


Figure 2- The double-slit experiment with waves

http://www.thestargarden.co.uk/ProblemsWithLight.html
http://www.thestargarden.co.uk/QuantumMechanics.html

Before analyzing Figure 2 in detail, it is interesting to mention that Young's double-slit experiment, as demonstrated on November 24, 1803, to the *Royal Society of London*, did not actually use a double slit; instead a narrow beam of sunlight was split by the edge of a thin card, achieving the same result as a double-slit.

Based on Figure 2, we can see that the bright fringes on the whole pattern are **parallel but not equally spaced**. The distance between neighbor fringes increases step by step on two sides of $\mathbf{n_0}$, symmetrical about the central bright fringe $\mathbf{n_0}$. In other words, the distance between fringe $\mathbf{n_1}$ and fringe $\mathbf{n_2}$ is more than the distance between $\mathbf{n_0}$ and $\mathbf{n_1}$, the distance between $\mathbf{n_2}$ and $\mathbf{n_3}$ is more than the distance between $\mathbf{n_1}$ and $\mathbf{n_2}$, and so forth. The related calculation also confirms this geometric explanation which is quite general. Furthermore, for simplification of calculations, the mathematical discipline of Young's theory is based on some assumptions that could not lead to a sound and accurate result, especially at very small scales. We should not forget that all these are the inherent characteristics of Young's wave theory.

3. The Real Pattern of Double-Slit Experiments

In the current dominant paradigm, there are several terminologies that are used frequently such as "photon waves", "atom waves", "matter waves" or even "electron waves". The purpose is to merge, very easily and without any headache, the particle theory with the wave theory; because the so called "*Complementarity Principle*" of Niels Bohr (1885-1962) in quantum mechanics is the final word and it should not be questioned anyway!

Since about 50 years ago, the progresses and improvements in technology have opened the door for implementation of high precise double-slit experiments, especially those that have been carried out with single photons, electrons and atoms. My approach for analyzing Young's theory is the comparison of its inherent geometry with the outcomes of these precise experiments, it is very easy. Let us first have a short look at the history of these modern experiments:

The electron double-slit experiment was eventually performed in 1961, by *Claus Jönsson* of Tübingen; during a fellowship at the University of Tübingen in 1973 and 1974, *Tonomura* worked with *Gottfried Möllenstedt* (1912-1997), who was the first researcher to observe electron diffraction patterns by developing electron biprism diffractionometers; the single electron double slit experiment was performed by *Pier Giorgio Merli* (1943-2008), *Gian Franco Missiroli* and *Giulio Pozzi* in Bologna in 1974, and repeated by *Akira Tonomura* and co-workers in 1989. The latter has been discussed in detail in one of my articles titled: "***Against Wave-Particle Duality Concept***", published in **toequest.com**, August 2010. Therefore, two other real patterns of double-slit experiment, released by credible sources, have been introduced here, as shown in Figures 3 and 4:

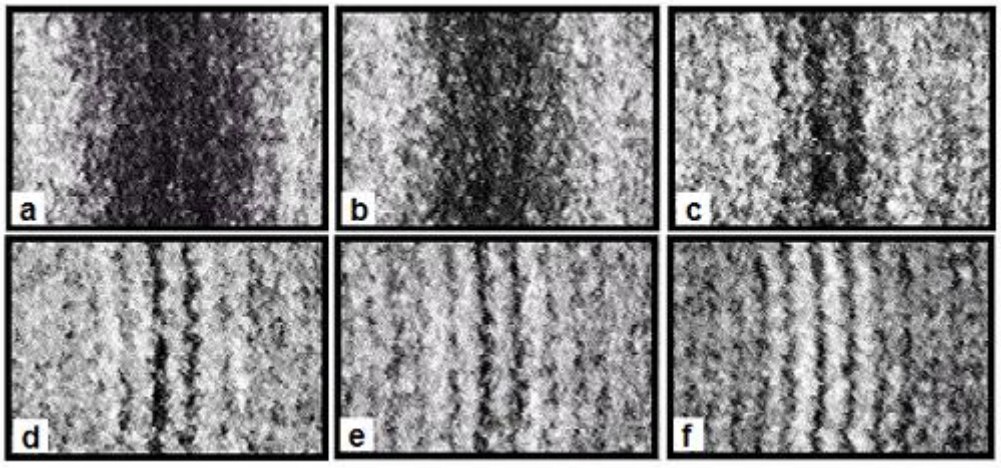


Figure 3- Diffractionometry with Electrons
Carried out at the Technical University of Vienna (Austria)
http://www.ati.ac.at/~summweb/ifm/main.html

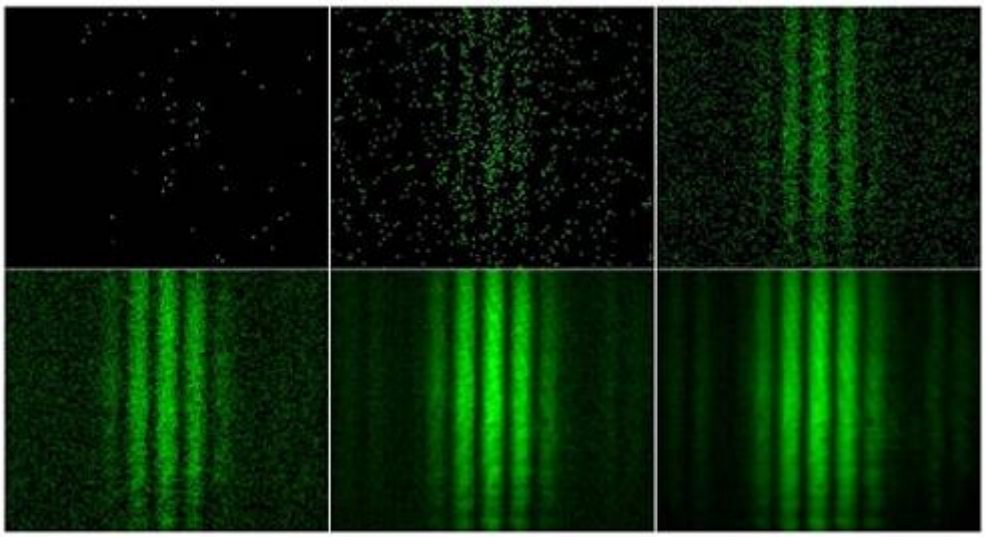
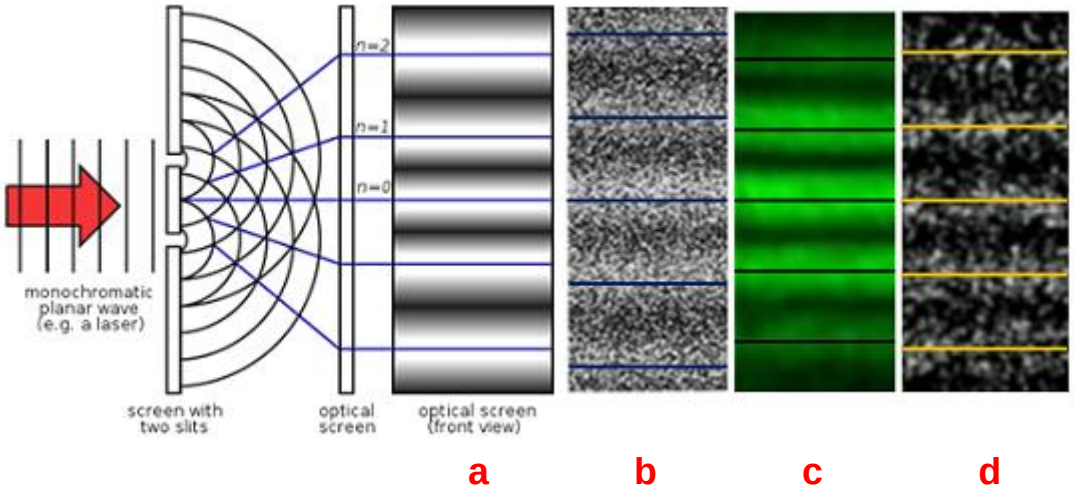


Figure 4- Diffraction of Individual Photons
Recorded by Antoine Weis, University of Fribourg (Swiss)

Wave-particle duality of light for the classroom !

Apart from differences between these two real patterns that are explainable and stem from the nature of particles in each case namely electrons and photons, there are some similarities between the patterns. As a matter of fact, in both cases, all fringes on the whole pattern are **parallel and equally spaced**. These similarities are common in all patterns of modern double-slit experiments. But we have mentioned before that the fringes based on the mathematical discipline of wave theory are **parallel but not equally spaced**. This geometric discrepancy is a decisive reason for the failure of Thomas Young's wave theory. The ultimate authority in science is nature.

The possibility for a more accurate comparison between some of the aforementioned patterns and the pattern of Thomas Young's wave theory has been provided in Figure 5.



a) Pattern of double-slit experiment based on *Thomas Young* wave theory
b) Pattern of double-slit experiment with single electrons, *Hitachi (Japan)*
c) Pattern of double-slit experiment with single photons, *Fribourg University (CH)*
d) Pattern of double-slit experiment with single photons, *Leiden University (NL)*

Figure 5- Comparison of real patterns of double-slit experiment with the pattern of Thomas Young's wave theory

4. The Logical Paradigm

In my opinion, one of the most important causes of incorrect interpretations of quantum mechanics is Thomas Young's wave theory. But we should take into consideration that about two hundred years ago, in addition to insufficiency of natural sciences at that time, nobody knows anything about quantum mechanics and also the technological possibilities were very limited. All these could satisfy us, to some extent, to accept that it has been very difficult for Thomas Young to compare correctly the mathematical outcomes of his theory with the observed pattern of his double-slit experiments. What should be done now?

I strongly recommend the engineering students and also the curious readers, who are truthfully and impartially interested to be familiar with a logical paradigm of quantum mechanics, to study the following articles step by step respectively.

Marcel Proust said**:** "*The real journey of discovery consists not in seeking new landscapes, but rather in looking at the world with new eyes*."

1. Definition of Uncertainty**,** (German Version)
2. Wave Function, Developed Gaussian Distribution**,** (German Version)
3. Against Wave-Particle Duality Concept**,** (German Version)
4. Exact Planck Length Unveils Quantum Gravity**,** (German Version)