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Newtonian Wave-Particle theory of Light

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Newtonian Physics can deal adequately with the wave-particle duality of light, and was the foundation of Newton's theory of light when he first formed it. Distortions subsequently in the presentation of physics have to a large extent hidden that fact.

Modern Physics now forgets Newton's wave-particle theory of light, but references to that theory can still be found in some obscure places such as Britannica (1971), which says:

"Hooke was a critic of Newton's corpuscular (particle) theory of light. Hooke had developed a wave theory of light, according to which light consists of a series of pulses transmitted through a medium pervading space, the universal ether." [1]

These pulses must be like particles.

"Newton in his explanation of optical phenomena indicated that corpuscles of light might be guided by waves in an ethereal medium." [1]

i.e. Newton had a wave-particle theory of light.

There was animosity between Newton and Hooke, but Newton could not agree with a lot of people; so that probably stopped Hooke and Newton agreeing with each other – on personal differences rather than on science. From looking at the science independent of their personal differences then their science was similar. However, Newton found a problem:

"Newton rejected a simple wave theory of light because it could not account for rectilinear propagation or for polarization. As Newton demonstrated, all wave phenomena- for instance, sound – carry the disturbance into the region of shadow, or around obstacles. It never occurred to him that the waves of light might be exceeding small." [1]

Note this as --- point 1

And there was another problem:

"Newton's corpuscular theory of light had light going more quickly through optically dense material such as glass. And in the 19th Century, experiments showed light travelled slower the denser the medium." [2]

Note this as --- point 2

So these two slips by Newton stopped him fully realising a wave-particle theory of light.

However—

"Yet in the studying of the colours of thin plates, Newton provided much of the necessary information for the later wave theorists."

"Thomas Young showed that Newton's careful measurements led to an accurate determination of the wavelength of the several colours."

"Thomas Young in 1804 and the work of Augustin Fresnel a few years later developed a fully developed description in terms of wave theory covering the phenomena of light as then observed."

"Young drew on Newton's concepts of waves as well as on the views of Christiaan Huygens."

"According to Newton it had seemed probable that light consisted of a series of corpuscles emanating from luminous bodies. These corpuscles give rise to waves as they travel through the ether." [1]

So the theory of light in the 19th Century should have been Newton's wave-particle theory of light after Newton's slips had been corrected.

However, Britannica notes that this explanation [of wave-particle] fell from favour in the 19th century when the solely wave theory became fashionable.

Then of course Einstein writes about photons in 1905, and the wave-particle theory comes back.

Britannica says: "many writers have called attention to a similarity between Newton's views and that of the 20th century, in which there is a fusion of elements of both wave and corpuscular theories of light."

So after stumbling a bit with Newton's wave-particle theory of light it came back again in the 20th Century modified to correct for its mistakes (of note – (1) and (2)). (Unfortunately modern physics texts miss that connection.)

I have looked for any Physics History book dealing with mentioning Newton's wave-particle theory of light and cannot find one easily; apart from this mention in Britannica they all seem to ignore that theory.

It seems a general attitude by modern physicist to ignore their history.

Inference of the existence of Newton's wave-particle theory can however be made by brief cryptic comments in some physics texts, such as Feather's book dealing with vibrations and waves he says:

"those who followed Newton and regarded a beam of light as essentially a stream of discrete particles.." [3]

When he says "essentially" I suppose we are supposed to interpret that as meaning Newton's light theory is mainly a particle theory, but we could easily miss such a comment and take it that Newton's theory is solely a particle theory of light; and there is no explicit statement in over 300 page book on waves and vibrations that Newton had more than a particle theory of light. Ideally one would expect that a text dealing with waves and light should say more about the connection to Newton's wave-particle theory. But as standard practice by such texts they ignore mentioning many items which should ideally be mentioned.

One can speculate that these physics texts find it easily to represent Newton's theory of light as solely a particle theory, then when it comes to discussing light before Einstein they contrast the particle theory of light with the wave theory of light. They then can point out phenomena that each theory can and cannot explain, i.e. point out the benefits and deficiencies of each theory. But they miss out talking about a theory combing both wave and particle in one description of light until Einstein, and then they credit it to him and his followers for that theory.

It's just a misrepresentation of history of physics and the theoretical development of physics for the benefit of supposedly making it easier for students of physics. Students of physics are presented a history where there is a clash of solely particle theory versus solely wave theory of light in their initial courses, and if they progress to physics dealing with Einstein they are then told about the wave-particle theory of light but misrepresented usually as starting with Einstein not Newton.

i.e. we have misrepresentation of history to physics students – supposedly so as to make the physics they are learning easier.

The poor physics students then get a distorted version of their physics history and a completely false belief implanted into them as to how the physics really developed.

Of course when they (the physics students) touch upon the wave-particle duality of light they are then usually being introduced to Quantum mechanics and then it is presented as being mysterious this – wave-particle duality of light along with other mysterious things that Quantum mechanics introduces. The students are then usually advised that just to accept the mysterious nature of Quantum mechanics and deal just

with solving the maths problems. All of that is implanted into them instead of showing them the true history of physics from which the connection of ideas would seem more non-mysterious.

J.T Mendonça notes:

"The wave particle dualism is usually considered in the context of quantum physics, and we have the tendency to forget that it also takes place in classical physics." [4]

Mendonca continues:

"Although not denying the existence of the ether, Newton assumed that light is something else and, following the atomistic tradition and along the lines of Gassendi, described light as made of particles, with different energies and sizes. Therefore, light rays could be described as streams of corpuscles." [4]

So we have this interesting connection that the light-particles of Newton are the medium for light.

There has been an Atomistic tradition of reducing everything in nature as being made up from small particles, this dates back to the ancient Greek philosophers. So if we think of light as a wave in a medium, then by that atomistic tradition – the medium would be made of particles.

Mendonca deals with some more of the connection between classical (Newtonian Physics) waves and Quantum waves:

"Here we will concentrate on the ability of Maxwell's equations to describe both the wave and particle aspects of light; in a sense, to incorporate complementarity. This property has been known for many years, but is very often overlooked because our usual way of thinking is dominated by the opposition between classical and quantum mechanics. We therefore erroneously tend to identify the particle behaviour with classical physics and the wave behaviour with quantum mechanics. The fact is that the classical theory of radiation provided by Maxwell's equations is able to describe the wave–particle dualism. Only in the modern field theory are light and matter described on equal footing. We should, however, keep in mind that a particle has different meanings in classical and quantum theories. In classical terms, a particle, such as a photon, can be associated with a small wave packet. In quantum field theory, a particle becomes an elementary excitation of a given quantum field." [4]

So we have to note here a different interepretation of the Quantum and Newtonian particles (which I will question anon).

And interesting comment by Mendonca is:

".. photons can be accelerated and trapped in many different conditions. In this sense, they behave as any other particle. This occurs, for instance, in a plasma, where

relativistic electron plasma waves (produced by an intense laser pulse or by a relativistic electron bunch) can trap and accelerate photons belonging to another test pulse or to the driver pulse itself .. This can also occur in a dielectric crystal, where infrared or visible photons can be accelerated by terahertz polaritons … Or even, in more exotic situations, photons travelling in vacuum can be accelerated (or energized, or frequency upshifted) by moving gravitational fields … or going outside the frame of classical theory, by nonlinear quantum electrodynamics effects …. " [4]

The tendency of beginners texts on relativity is to treat light speed as constant, here he talks of it as variable. As is the way of physicists they probably are treating slight speed as constant in Special Relativity in its simplest formulation, but then want an update of having it variable when adding quantum effects.

It is in general an unfortunate habit of physicists to treat things first in a simple context and then want to add more features later in an updated context. This can lead to a lot of confusion, because there are those who only understand the simpler context and don't have the updated context. Such people who are unaware of this process can insist that lightspeed is constant, and be unaware that is only in a simple context; with the physics community modifying that simple context later in a more broad ranging theory.

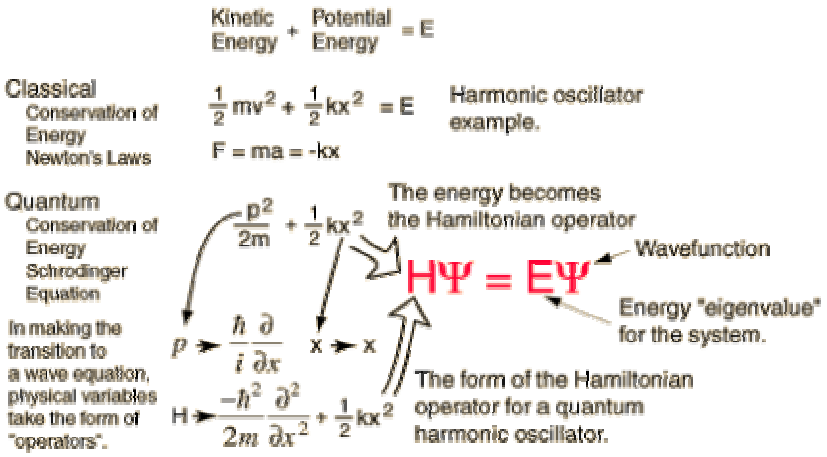
There are sort of layers to understanding physics as a result of the way physics is taught; at early levels a simplified treatment (i.e dumbed down) version of a topic are taught, and at higher levels modifications are added. Arguing can occur by those who believe the dumbed down version too literally and never progressed higher. Then in the higher levels of course they are is often no agreement.

If we now look again at the two features of Newton's light-particle theory that were wrong, namely:

1. It can be demonstrated that light bends towards the normal when moving from air to water. Newton believed that water attracted light particles, therefore, the particle's speed increased. This increase in speed would cause the particle's path to bend towards the normal.
2. This view predicts that the speed of light in water was greater than in air. In 1850 Foucault showed that light travelled slower in water than in air The particle theory [of Newton] must, therefore, be wrong. [5]

This sort of thing is taught at schools, and I obtained it from a teacher website. The particle theory modified so that light goes slower through denser medium (such as water) is the type of light-particle theory we are now more familiar with.

If we now move onto the creation of Quantum mechanics; Hyperphysics website shows the basic construction of the Schrodinger equation [6]:



The construction starts off from E = Kinetic energy + Potential energy, this is basically Newtonian Physics and converts that to a wave equation. The essential feature of this conversion process is the introduction of the wavefunction [7]:

$$\Psi(x,t) = Ae^{ikx - i\omega t}$$

So basically it is multiplying Newtonian Physics equation by this wavefunction which is a complex number. This is exactly what Nahhas shows [8] [9] of a solution in Newtonian Physics motion being missed. It is thus up to this point just Newtonian Physics.

But what happens is a reinterpretation of this Newtonian Physics equation from a new philosophy that turns it into what we now know today as Quantum mechanics.

As Stanford Encyclopedia of Philosophy website points out [10]:

“As the theory of the atom, quantum mechanics is perhaps the most successful theory in the history of science. It enables physicists, chemists, and technicians to calculate and predict the outcome of a vast number of experiments and to create new and advanced technology based on the insight into the behavior of atomic objects. But it is also a theory that challenges our imagination. It seems to violate some fundamental principles of classical physics, principles that eventually have become a part of western common sense since the rise of the modern worldview in the Renaissance. So the aim of any metaphysical interpretation of quantum mechanics is to account for these violations.”

“The Copenhagen interpretation was the first general attempt to understand the world of atoms as this is represented by quantum mechanics. The founding father was mainly the Danish physicist Niels Bohr, but also Werner Heisenberg, Max Born and other physicists made important contributions to the overall understanding of the atomic world that is associated with the name of the capital of Denmark.”

"In fact Bohr and Heisenberg never totally agreed on how to understand the mathematical formalism of quantum mechanics, and none of them ever used the term "the Copenhagen interpretation" as a joint name for their ideas. In fact, Bohr once distanced himself from what he considered to be Heisenberg's more subjective interpretation (*APHK*, p.51). The term is rather a label introduced by people opposing Bohr's idea of complementarity, to identify what they saw as the common features behind the Bohr-Heisenberg interpretation as it emerged in the late 1920s. Today the Copenhagen interpretation is mostly regarded as synonymous with indeterminism, Bohr's correspondence principle, Born's statistical interpretation of the wave function, and Bohr's complementarity interpretation of certain atomic phenomena."

So, really what we have is an equation from Newtonian Physics, which the Establishment never really fully agreed how to interpret. (Note the Copenhagen interpretation tended to be enforced as dogma as the way "it" ought to be interpreted.) The question becomes why this equation interpreted other than from the standard Newtonian Physics way; for which the answer seems to be that it was mostly missed in all of this confusion of the creation of Quantum mechanics that it was based on this type of Newtonian Physics highlighted here.

Beneath this disagreement in mainstream physics there are articles noticing the connection to Newtonian Physics, such as, Trevor Marshall who says [11]:

"I argue that Newton's theory of Optics - as presented in his "Opticks" of 1704 - does not differ greatly from modern Quantum Optics. If we apply any of the modern theories of how science progresses, for example Popper's, we should judge that some of his contemporaries had a better description of interference, diffraction and double refraction than had Newton, and that evidence already available at the end of the seventeenth century confirmed their superiority. This indicates that ideological, rather than scientific criteria were brought to bear during the subsequent century, to bar progress in the understanding of Light."

If we now add this to the fact that (by Nahhas and others) that the calculations which supposed can only be done by Einstein's relativity, but which can really be done still from Newtonian Physics- hence no need for Einstein's Relativity Revolution; we then have a theory combining both quantum realm and relativistic realms – namely Newtonian Physics. And then all of the confusions and dis-unification between theories in the 20th Century was caused by the physics community being unable to agree on looking at the latest advancements in physics as a continuation of Newtonian Physics, but instead wanting to look at things in a multitude of different ways,

References

[1] Encyclopedia Britannica, vol.16 1971, p 420

[2] ibid p 419

[3] The Physics of vibrations and waves, Norman Feather FRS, Edinburgh University Press, 1963, p 254

[4] Maxwell and the classical wave particle dualism, J.T Mendonça, Philosophical Transactions of the Royal Society, Trans. R. Soc. A 28 May 2008 vol. 366 no. 1871 1771-1780 http://rsta.royalsocietypublishing.org/content/366/1871/1771.full

[5] http://schools.cbe.ab.ca/b858/dept/sci/teacher/zubot/Physics20/..%5CPhys20notes%5CChapter14%5C1chapter14%5C1ch14.htm

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[9] Einstein's Nemesis#1: DI Herculis Apsidal motion puzzle solution By Professor Joe Nahhas http://www.wbabin.net/physics/nahhas.pdf

[10] http://plato.stanford.edu/entries/qm-copenhagen/

[11] Wave-particle duality in the seventeenth century, Trevor Marshall: http://philica.com/display_article.php?article_id=44