Connection Between Planck's Relation and Non-Existence of Medium for Light Propagation and Predetermination of Photon and Electron Interference Patterns in Double-Slit Experiments

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Abstract

The puzzles of quantum mechanics are: 1. What is the medium for the photon and for the electron wave? i.e. *what* is waving? 2. How can a particle have an interference pattern 3. Observer effect. 4. Entanglement. In Quantum Erasure and Double-Slit experiments, how does the emitter know to direct the photon two both slits or only to one slit? And how does the detector know where to detect the photons to form an interference pattern and not a bell-shaped (Gaussian) pattern or vice versa? This paper proposes that the hint in the mystery of light waves without a medium (ether) is contained in the Planck's relation itself: $E = hf$. It is shown that Planck's relation itself hints on the mystery of light waves without medium, and is a consequence or manifestation of non-existence of a medium for light propagation. The subtle law of nature that has eluded physicists so far is that the photon energy density (amplitude of electric and magnetic fields) at a given point in the spatial dimensions of the photon is directly related to the *rate of change* of the electric and magnetic fields at that point. The higher the frequency of the photon, the higher the rate of change of the fields at every point for that photon, compared to a photon of lower frequency. The higher the rate of change of the fields at a given point, the higher the amplitude of oscillation of the electric and magnetic fields at that point. It follows that the higher the frequency of the photon and the higher the amplitude of the electric and magnetic fields, which results in high intensity of vibration of the photon, the more localized it will be. A high frequency photon will spread less in space than a lower frequency photon of equal envelope amplitude because, if the high frequency photon spreads out, there would be high rates of change over a wider region of space, and the total energy would be greater than the finite photon energy. The photon energy will always be concentrated at regions of high rate of change of electric and magnetic fields. This theory explains how electric and magnetic fields can be their own 'medium' , 'dragging' of the electromagnetic energy by the wave, hence eliminating the need for any medium. Since the electromagnetic wave (the photon) is a traveling disturbance of electric and magnetic fields, the rate of change of the fields at a point in space will create the intensity (amplitude) of the fields at that point. Likewise, the electron wave is a travelling disturbance of the electron mass density wave on the electron 'sea'. The higher the frequency of mass density variation of the electron at a given point of space, the higher the mass density of the electron at that point. This will make the electron (the electron 'sea') its own medium of propagation. i.e. the electron 'sea' is the medium of propagation for the electron wave. This means that the electron wave 'drags' the electron with itself. The other theory proposed in this paper is the predetermination of interference fringes in double-slit experiments and predetermination of which slit the photon takes in which-way or quantum erasure experiments. We propose a fundamental law of nature that an electron, an atom or any source of electromagnetic waves will always emit a weak, continuous electromagnetic energy even when not excited, which implies that electrons and atoms are always in continuous, fundamental, weak vibrations (accelerations). Therefore, in double-slit experiments

and in quantum erasure or which-way experiments, the atom (electron) of the light source is always emitting weak, continuous electromagnetic waves, even before the atom is excited. Therefore, even before the atom/the electron of the light source starts emitting a photon, a weak electromagnetic (light) wave exists *as an entity*, extending all the way from the light source (the atom) to the slits and to the detecting screen. This 'precursor' wave serves as the 'highway' for the propagation of the main photon energy packet, both of which are coherent and exist as an entity. When the atom is excited, it will just emit a photon that is coherent with the weak wave it had already been emitting continuously. Therefore, even before the atom is excited, a weak wave interference pattern already exists on the screen. The photon emitted after excitation simply follows the path already created by the weak 'precursor' wave and will land on the screen according to the predetermined interference pattern, collapsing to the point of detection at the instant of detection. The path to be taken by the photon is predetermined in which-way or quantum erasure experiments. The same theory explains quantum entanglement: the polarization of two entangled photons is predetermined even before the excitation of the atoms emitting the photons.

Key words:

Quantum mechanics interpretation, Double-slit experiment, Planck's relation, quantum erasure / which-way experiment, quantum entanglement

Introduction

The fundamental nature of light had been a mystery for centuries since Newton, who held the view that light is made of particles (corpuscles). Christian Huygens' proposed the wave nature of light. With lack of any technological means to test these hypotheses during those 'dark' days, there was no means to make a final decision between the two hypotheses.

The first experimental evidence on the fundamental nature of light arrived with Thomas Young's double slit experiment, which, for the first time, revealed the wave nature of light. The scientific community held this view for centuries until the end of the 20th century, when Max Planck discovered the particle nature of light (the quanta) from experimental data on black body radiation and when Albert Einstein used Planck's theory to successfully explain the photoelectric effect. This revealed the wave-particle dual nature of light and is the birth of quantum mechanics. Quantum mechanics gradually developed into its probabilistic (Copenhagen) interpretation known today. Initial successes of quantum mechanics include the explanation of atomic orbitals by Neils Bohr and its successful prediction of Hydrogen emission lines.

Despite all empirical successes of quantum mechanics, fundamental questions remained unanswered. For example, what is the physical process underlying the electron interference pattern ? How can a particle have an interference pattern at all ? How can a light wave exist, but no medium for light propagation exists, as disproved by the Michelson-Morley experiment? Some scientists, including Albert Einstein, and many dissident physicists could never settle with the probabilistic (Copenhagen) interpretation. Recent experiments on quantum mechanics, the which-way or quantum erasure (quantum entanglement) have no real explanation to this day.

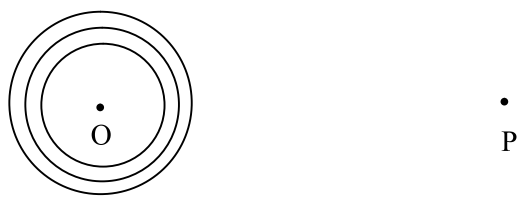
In my previous papers [1][2], I proposed a theory to explain the interference patterns in photon and electron Double-Slit experiments. A simple yet subtle law of nature of photons and electron waves was proposed. However, the theory was very compelling yet not complete.

This paper will further develop the insights described in previous papers[1][2].

The Double-Slit experiment - A new model for the photon and electron wave

The insight for explanation for the Double-Slit experiment will be proposed next.

Ordinary waves such as water waves, sound, string and solid waves are travelling disturbances of their material media. If we drop a stone into a pond, a packet of circular water waves will form and travel radially outwards, with its center O at a point where the stone was dropped. Let us see what happens at a certain point P on the pond some distance away from the origin of the wave.



Before the arrival of the wave packet, the water is standing still at point P. As the wave arrives, the water molecules start to oscillate vertically. After the wave packet has passed away, the water molecules become standing still again. The wave (the oscillation) disappears from point P.

Here we note a seemingly trivial yet key idea:
Disappearance of the water wave (oscillation) from point P doesn't mean disappearance of water molecules from point P. This idea is the basis of the distinction between ordinary waves and quantum waves (the photon, the electron wave).

At first consider the electron as a continuous field of electron mass density field distributed continuously in space, not as a point particle. With this picture, the electron is analogous to the pond water. Assume that a wave is created somehow in the electron 'pond', analogous to the water wave. If we assume direct analogy between the electron wave and the water wave, the electron *mass density* would be 'standing still' (not time varying) at point P before the arrival of the wave, its *mass density* oscillates as the wave arrives and becomes standing still again after the wave passes away. But from our ordinary experience of motion of particles we know that there will be no particle at a point until the particle arrives and after the particle has already passed through that point. The particle is detected at a point only when it arrives at that point.

Therefore, we need to modify this direct analogy for the electron wave as follows:

There will be no electron (electron mass density is zero) at point P before the arrival of the electron wave and after the electron wave has passed away. *The electron mass density disappears (becomes zero) from point P with the disappearance of the wave/the disturbance*. Unlike the water wave, the medium for the electron wave, which is the electron mass density field itself, exists at a point only when the wave (oscillation) exists (is non-zero) at that point. This means that the electron wave drags the electron (the electron medium) with itself. Where and when there is no electron wave (oscillation), i.e. when and where the amplitude of the wave is zero, there will be no electron; the electron mass density will be zero then and there.

The puzzle can now be resolved:

"If an electron is a wave, then what is the medium for the electron wave? What is waving ?"

The electron is both the medium and the wave. The medium for the electron wave is the electron mass density field itself. No exotic medium is required. (The same is for the photon- to be discussed later on).

The electron interference pattern in the single electron Double-Slit experiment can be explained as follows. As the electron is fired towards the plate with two slits, it propagates as an *electron mass density wave* packet, with a specific frequency and wavelength. The wave fronts meet the two slits and pass through the slits. On the other side of the plate, the two slits act as two sources. Along the detector screen, the waves from the two slits interfere with continuously varying degrees of constructive and destructive interference. At some points, the waves may interfere completely constructively, and at some other points completely destructively. At points of complete destructive interference, the amplitude of the wave (the amplitude of electron mass density oscillation) will be zero. At points of complete constructive interference, the amplitude of the wave will be maximum (the intensity of the mass density oscillation will be maximum) and hence the RMS mass density of the electron will be maximum at those points. The electron will collapse at the point of detection on the screen and the probability of detecting the electron is higher at points of higher wave amplitude. At points of zero wave amplitude on the screen, the probability of detection will be zero.

As the electron is a particle, it can be detected at only one point on the screen. At this point it is logical to assume that the electron will be more likely to be detected at points of higher electron mass density and less likely to be detected at points of less electron mass density. Therefore, the electron will never be detected at points where the amplitude of the wave is zero, i.e. at points of complete destructive interference. Therefore, the probability that the electron will be detected at a certain point on the detector screen is directly related to the amplitude of the mass density oscillation of the electron at that point. Unlike the 'probability' in the Copenhagen interpretation, the 'probability' here is in accordance with the principles of causality and determinism. At the instant of the detection at a certain point, the electron field 'collapses' to that point.

The explanation for the interference pattern in Double-Slit experiment for the photon is similar to that of the electron, but with 'photon energy density' instead of 'electron mass density'.

Let us consider the pond water wave analogy again. If we take direct analogy between a water wave and a photon, then we observe a static electric and magnetic field at point P before arrival of the photon wave, then a time varying electric and magnetic field as the photon arrives, and a static electric and magnetic field again after the photon has passed away.

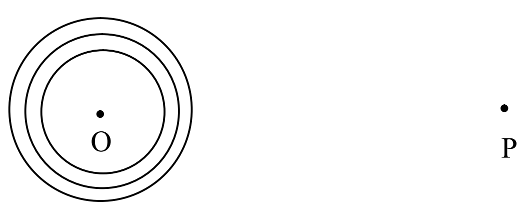
This direct analogy is wrong and is to be modified for the photon as follows. There will be no static or time varying electric and magnetic fields at point P before the arrival of the photon, there will be time varying electric and magnetic fields as the photon arrives and there will be no static or time varying electric and magnetic fields after the photon has already passed through point P.

Connection between Planck's relation and waves without medium

The law of nature behind quantum phenomenon is proposed as follows.

The intensity (amplitude) of electric and magnetic field oscillations at a given point within the spatial dimensions of a photon is related to the rate of change of electric and magnetic fields at that point. The higher the frequency and the higher the amplitude of oscillation of electric and magnetic fields at a given point, the higher the rate of change of the fields at that point, which in turn results in higher amplitude of oscillation at that point.

With our the pond water analogy again, we can now explain how the photon propagates without a medium.



Suppose that a stone is dropped at point O in a pond. Point P is another distant point on the pond. The water at point P stands still before the waves arrive and after the waves have passed away.

When the waves are just passing through point P, the water molecules at point P oscillate vertically. Trivially, passing/disappearance of the waves only means disappearance of the disturbances, not disappearance of the water.

Let us use this analogy for light waves. Imagine a 'pond' or 'sea' of static electric and magnetic fields. This 'sea' of electric and magnetic fields is somehow disturbed at point O, creating electromagnetic waves traveling in every direction from point O. With analogy to the water wave, there will be oscillation of electric and magnetic fields while the wave is passing through point P. The electric and magnetic fields are 'standing still' or static at point P, before the arrival of the electromagnetic wave and after the wave has passed away.

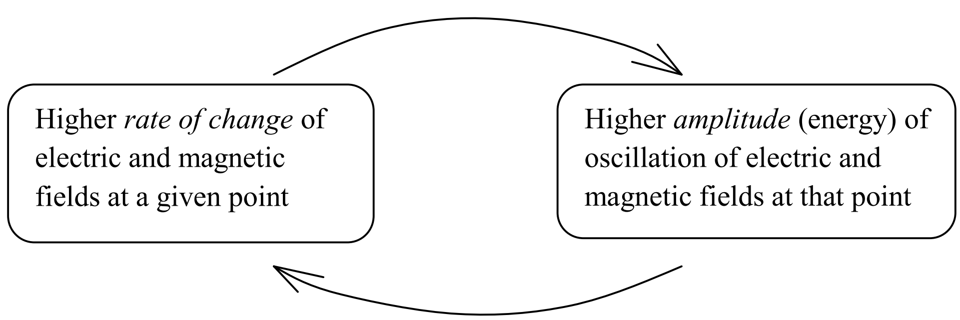
The crucial distinction between water wave and electromagnetic (light) waves is that, unlike water waves, there will be no static electric and magnetic fields at point P before arrival of the wave and after the wave has passed away. Unlike water waves, passing of the wave means disappearance of any static (and dynamic) electric and magnetic fields from point P.

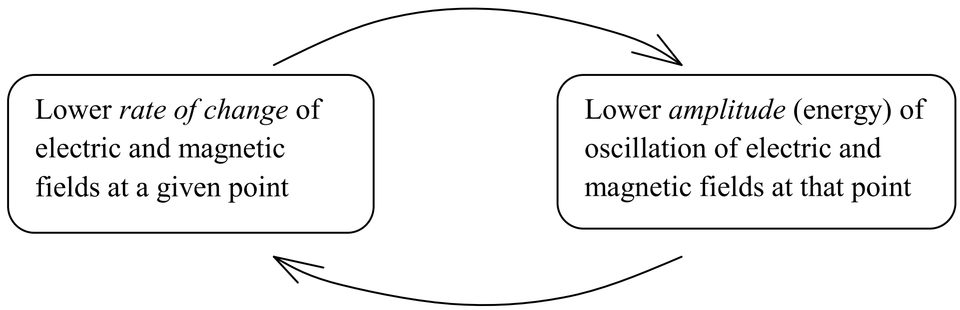
The question is :

How do the electric and magnetic fields propagate (be 'dragged') with the wave? i.e. how do they disappear once the electromagnetic wave has passed ?

The simple yet subtle trick of nature is as follows:

The intensity (amplitude) of the oscillation of the electric and magnetic fields of the photon at a given point in the spatial dimension of the photon is directly related to the *rate of change* of the electric and magnetic fields at that point. The higher the amplitude and the higher the frequency of oscillation of electric and magnetic fields at a given point in the spatial dimensions of the photon, the higher the rate of change of the fields at that point, which in turn creates higher amplitude of oscillation at that point, which creates higher rate of change of the fields at that point, and so on, until an equilibrium is reached. Note that the frequency of a given photon is always fixed, at all points in the spatial dimensions of the photon.





That higher amplitude of oscillation creates higher rate of change can be easily understood as follows.

Suppose the electric field E(t) at a given point oscillates according to:

$$E(t) = A \sin \omega t$$

then the rate of change of electric field at that point will be:

$$dE(t) / dt = A\omega \cos \omega t$$

Now we can see how the electric and magnetic fields are dragged by the electromagnetic wave. Returning to our water wave analogy, once the electromagnetic field has already passed through point P, there will be no disturbance or oscillation of the fields, making the *rate of change* of the fields at that point zero, which in turn will make the amplitude (value) of the electric and magnetic fields at that point zero. Therefore, unlike water waves, there will be no static ('standing still') fields at point P, once the wave /disturbance is gone.

This is the mechanism electron and photon waves carry their own medium with themselves.

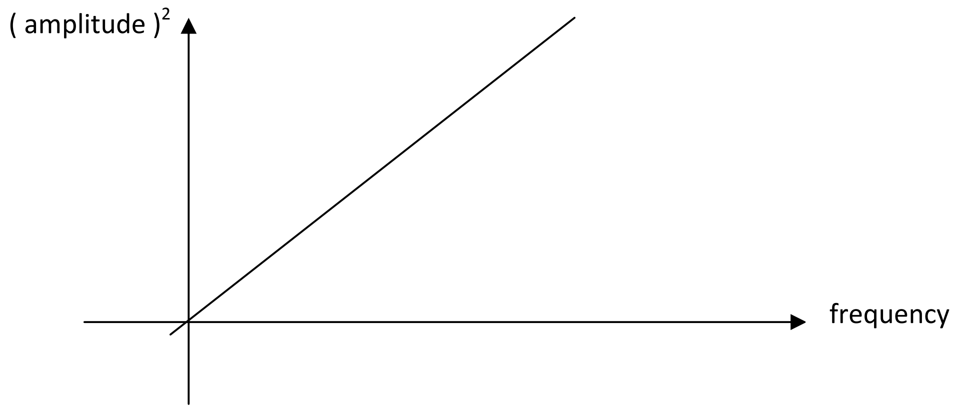
This explains how electric and magnetic fields propagate as a photon, without requiring a medium. This is mechanism the photon will remain localized and will not spread out during its propagation to even light years away. A high frequency photon will spread less in space than a lower frequency photon of equal envelop peak because, if the high frequency photon spreads out, there would be high rates of change of the fields over a wider region of space, and the total energy would be greater than the finite photon energy.

One can intuitively understand the law of nature underlying Planck's relation, E = hf. The new theory implies that the higher the frequency of oscillation of the light wave, the higher the maximum amplitude, i.e. the higher the peak of the envelope.

From Planck's relation, E = hf, the square of the amplitude of electric and magnetic fields is proportional to the frequency of oscillation. We know that modern physics gives no explanation as to why high frequency photons have high energies. The simple answer proposed here is that higher frequency photons have higher amplitudes.

Energy α f $\Rightarrow$ (Amplitude) ^{2} α hf

Note that this formulation may or may not be precise, but what should be noted here is that higher frequency photons, hence higher energy photons, have higher amplitude of electric and magnetic field oscillations.



One implication of this theory is that the spatial dimension of a photon is determined not only by the frequency of the photon, but also by the peak of the envelope, i.e. maximum amplitude of oscillation. Conventionally it is thought that high frequency photons are always highly localized in space. The new theory is that the spatial dimensions of a photon is determined not only by the frequency of the wave but also by the amplitude of the wave. We know that as the frequency of an electromagnetic wave becomes higher and higher, it will behave more and more like a particle.

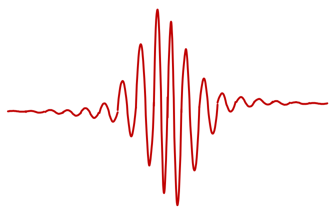
Conventionally, we know that:

For an electromagnetic wave of given amplitude of oscillation, the wave becomes more and more localized as the frequency of oscillation is increased and less and less localized (more and more spread) as the frequency of oscillation is decreased. This means that an electromagnetic wave of given amplitude behaves more and more like a particle with increasing frequency of oscillation and more and more like a wave with decreasing frequency of oscillation.

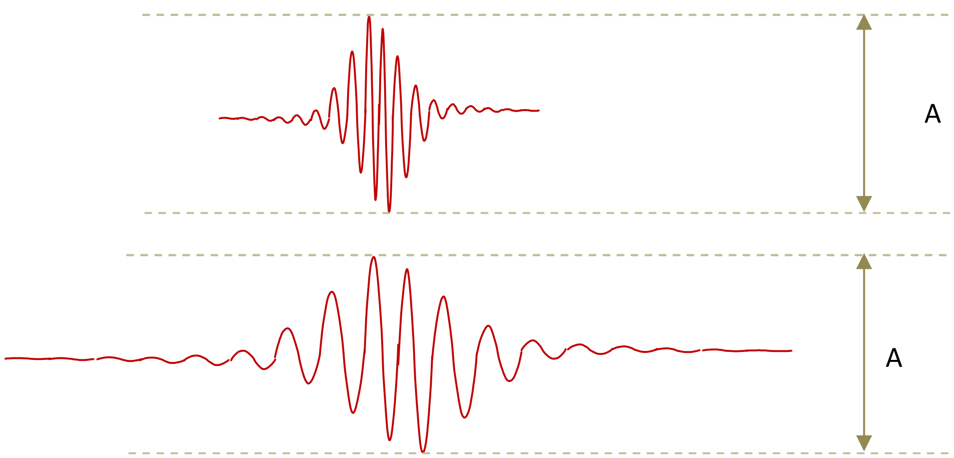
The new finding in this paper is that this is not all.

For an electromagnetic wave of given frequency, the wave becomes more and more localized as the amplitude of oscillation is increased and less and less localized (more and more spread) as the amplitude of oscillation is decreased. This means that an electromagnetic wave of given *frequency behaves more and more like a particle with increasing amplitude of oscillation of the electric and magnetic fields and more and more like a wave with decreasing amplitude of oscillation.*

The following figure shows two photons with equal frequencies but different amplitudes of oscillation, i.e. envelopes with different peaks. We can see that the photon with lower envelope peak has larger envelope width. It follows that as the amplitude of oscillation (the peak of the envelope) becomes smaller and smaller, the envelope becomes wider and wider and the radiation behaves more and more like a wave. But do all such photons with same frequency and varying envelop peaks and envelope widths have equal energies, as implied by Planck's relation?



The next figure shows two photons of equal peak amplitude (equal envelop peaks). The photon with higher frequency will be more localized than the photon with lower frequency.



The above theory implies that many photons can exist at a given frequency. The complete wave form of a photon is not determined by the frequency of the photon only, as believed conventionally, but also by the maximum amplitude of oscillation (the peak of the envelope).

In summary, a photon waveform is determined by:

1. The frequency of the wave

2. The peak of the envelope

Therefore,

as the frequency of oscillation increases and as the amplitude of oscillation increases, the wave will become more and more localized, and hence particle behavior dominates.

and

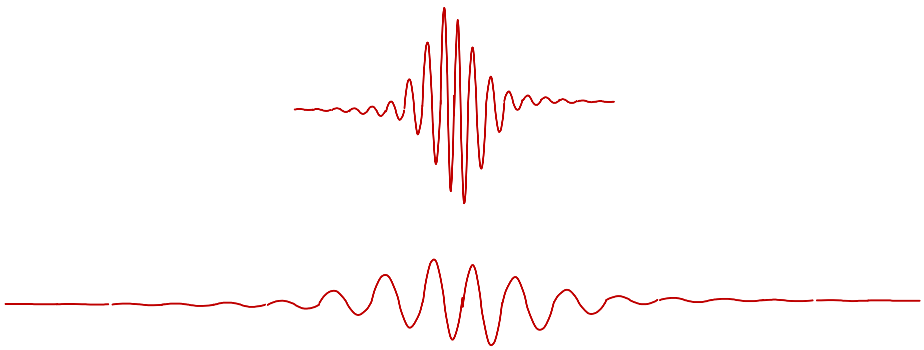
as the frequency of oscillation decreases and as the amplitude of oscillation decreases, the wave will become less and less localized, and hence wave behavior dominates.

The frequency and amplitude are both connected to the rate of change of the electric and magnetic fields. Therefore,

as the <u>rate of change</u> of electric and magnetic fields increases, the wave becomes more and more localized.

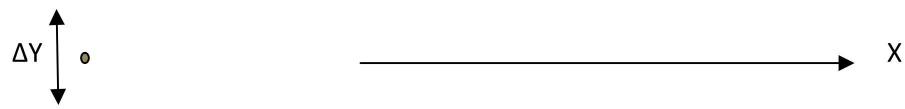
as the <u>rate of change</u> of electric and magnetic fields decreases, the wave becomes less and less localized.

The energy of photons observed so far, which are photons emitted by excited atoms, is known to be directly proportional to the frequency of the photons.



Modern physics tells us only that higher frequency photons have higher energy. It cannot explain why/how higher frequency photons have higher energies. The explanation proposed in this paper is that higher frequency photons have higher energies because they also have higher amplitude of oscillation of electric and magnetic fields.

To make the above ideas more clear, imagine an electron that is oscillating about a fixed point at a given frequency and amplitude of oscillation (ΔY).



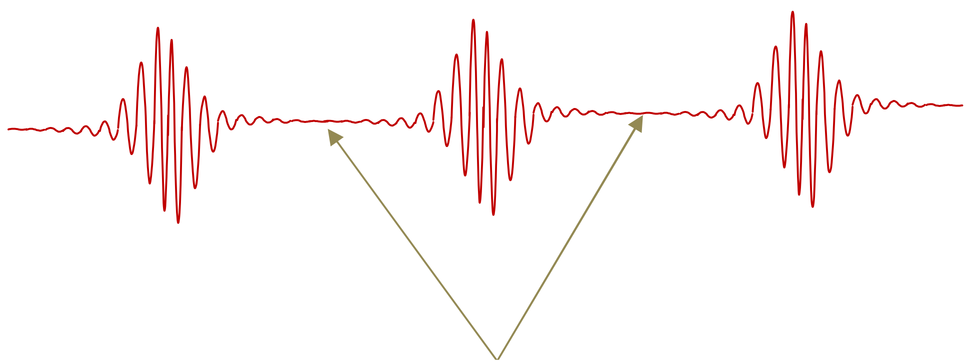
Since the electron is oscillating in the Y direction, it will radiate photons with maxima in the X direction. The theory proposed in this paper says that, <u>for a given amplitude</u> of oscillation (ΔY), the emitted photons will have higher peak amplitudes, i.e. higher envelope peaks, hence higher energies for higher frequency of oscillation. Moreover, the photon will be more localized with increasing frequency of oscillation. This means that as the frequency of oscillation of the electron is made lower and lower, the photon envelop peak becomes lower and lower and the photon becomes less and less localized, exhibiting more and more wave behavior.

And <u>for a given frequency</u> of oscillation of the electron, the envelop peak of the emitted photon increases as the amplitude of oscillation is increased, and the emitted photon will be more and more localized, exhibiting particle behavior. For a lower amplitude of oscillation, the emitted photon will have less envelop peak and spread (less localized), exhibiting wave behavior.

Let us see a profound implication of this theory. Imagine an electron that is *forced* to oscillate at a given frequency and amplitude of oscillation. But, the electron cannot emit electromagnetic energy continuously, as classically assumed . The electron emits electromagnetic energy only in chunks, not continuously. But we have assumed that the electron is forced to oscillate with constant frequency and amplitude, which will be in contradiction with the emission of electromagnetic energy in chunks.

This apparent paradox is rooted in our conventional thinking that it is possible to force an electron to oscillate indefinitely at a given frequency and amplitude. The new finding proposed in this paper is that it is fundamentally impossible to force the electron to oscillate with constant frequency and amplitude. Although the acceleration (motion) applied on the electron has always the same amplitude and frequency, the inertia of the electron will vary so that the electron always emits electromagnetic energy in chunks. At the instant when the photon has just emitted one photon, the inertia of the electron becomes nearly zero and no force is needed to accelerate it.

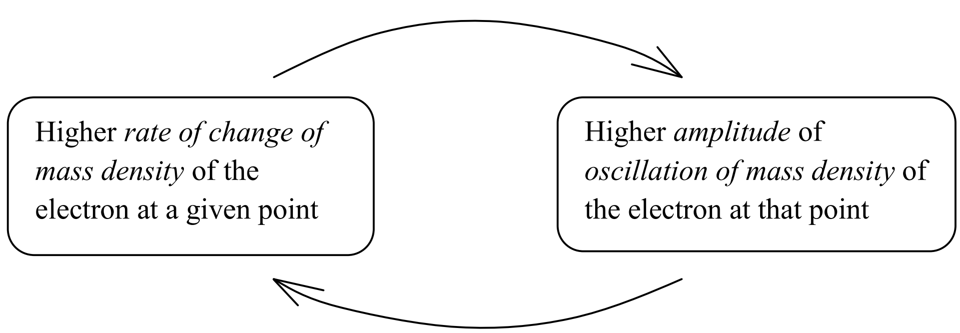
The following figure shows that the electron emits electromagnetic waves in chunks even though the applied acceleration (motion) always varies in the same way, with constant amplitude, frequency and phase. This author has already proposed that inertia is electromagnetic radiation reaction[3].



at these instants the electron is not emitting any electromagnetic wave, although they are accelerating. This implies that the inertia of the electron at these points becomes zero.

Basically the same theory applies for the electron wave.

The mass density at a given point in the spatial dimensions of the electron is directly related to the rate of change of the mass density of the electron at that point.



The electron should be visualized as a sea or 'pond' of electron mass density. To every point in the spatial dimensions of the electron is attached mass density of the electron at that point.

Returning to the pond water wave analogy, imagine the electron as a sea or pond of electron mass density. This means that just as the pond is made of nearly infinite number of water molecules, let us imagine the electron sea as infinitely small sub electron 'particles'. If we view the electron as a sea, then it will transmit electron waves just as sea water transmits water waves. Note that when we say sea of electron, we don't mean many electrons, we are viewing a single electron as a sea. Suppose that a wave is created in the electron sea at point O. The electron mass density wave will propagate in every direction from point O. The wave is a *travelling disturbance of the electron mass density*, just as water wave is a travelling disturbance of the water height, and just as photon is a travelling disturbance of the electric and magnetic field amplitudes.

Since we have assumed the electron sea, there will be non-zero, static (not time varying) electron mass density at point P, analogous to water waves. However, while we retain the analogy with water waves about the waves, we make the distinction that, unlike water waves, there is no electron mass density (electron mass density is zero) before arrival of the electron waves and after all the waves have gone past point P.

The mechanism of nature for this is stated above:

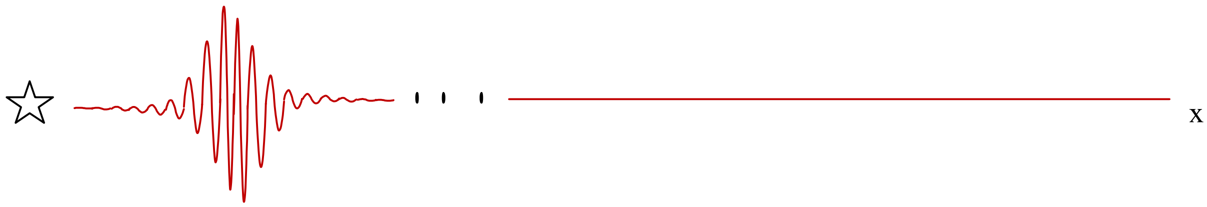
The <u>mass density</u> at a given point in the spatial dimensions of the electron is directly related to the <u>rate of change of the mass density</u> of the electron at that point.

Now, before the arrival of the electron wave and after the electron waves are gone past point P, there will be no waves, meaning no disturbances in mass density, which means no time varying electron mass density at that point, i.e. the rate of change of electron mass density at that point is zero. According to the above theory, zero rate of change of electron mass density means zero amplitude of oscillation of the mass density, which means zero electron mass density at that point.

Predetermination of interference fringes

In this section we will adopt the idea of a photon extending to infinite (large) distance[1], as proposed by this author, and we will adopt this idea with some modifications.

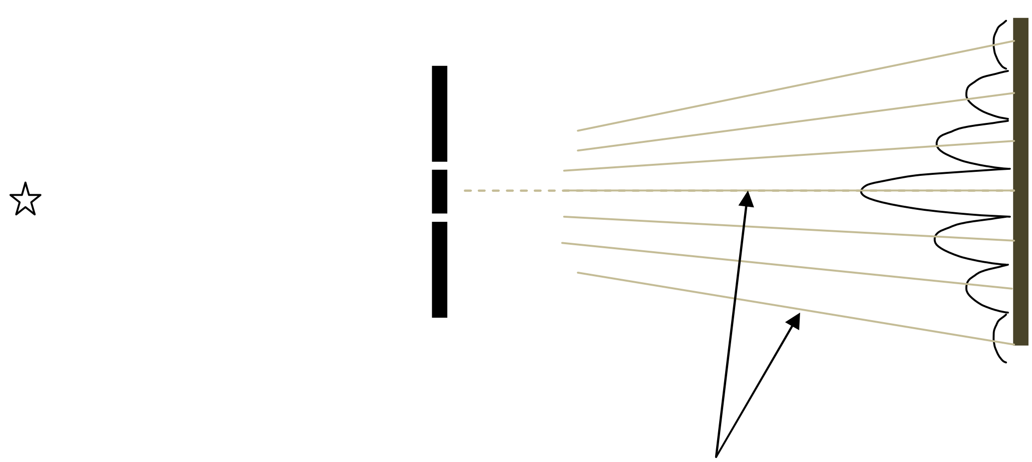
This section proposes a more natural and physical process underlying quantum phenomenon discussed above, such as single photon interference pattern and the which-way experiment. The idea proposed so far is that a photon with large length somehow comes into existence at the instant of light emission. The leading part of the photon serves as a precursor, as a 'highway' for the main photon energy propagation.



How can a photon extending to very large distance just come into existence instantly, at the instant of photon emission, as proposed in [1] ? This idea does not sound physical.

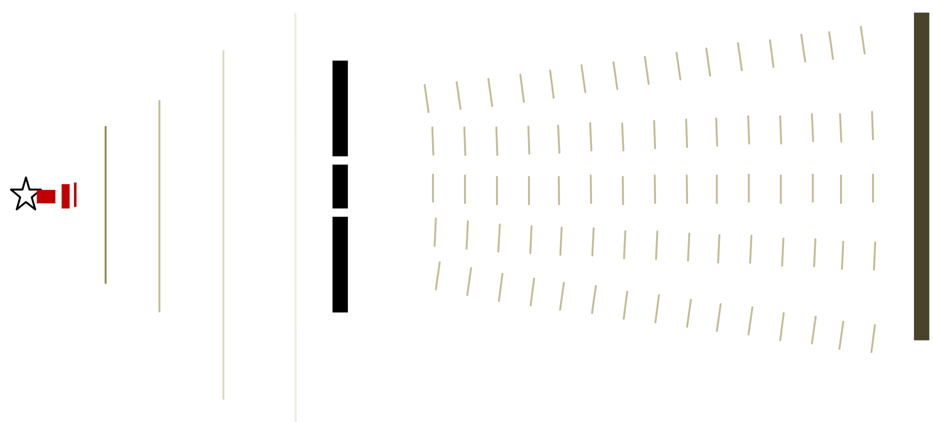
The new idea saving this otherwise compelling concept of a photon extending to 'infinity' (large length) is as follows. The emitting atom, the electron, continuously emits weak electromagnetic waves , even before the atom (the electron) is excited. This is assumed to be a fundamental law of nature. No atom, no electron can be absolutely at rest and has always infinitely small, continuous fundamental vibrations (accelerations). Therefore, the atom (the electron) continuously emits infinitely weak electromagnetic waves at all (probable) frequencies. We know that an excited atom (electron) emits light. But we have speculated that the atom/electron continuously emits an electromagnetic wave, a 'precursor wave'. What happens when the electron is excited is that it emits a photon that is just a continuation of (coherent with) the weak photon that it had been continuously emitting. The weak wave and the photon will exist as an entity, i.e. both are part of a single entity (photon).

Now we will consider the double slit experiment.

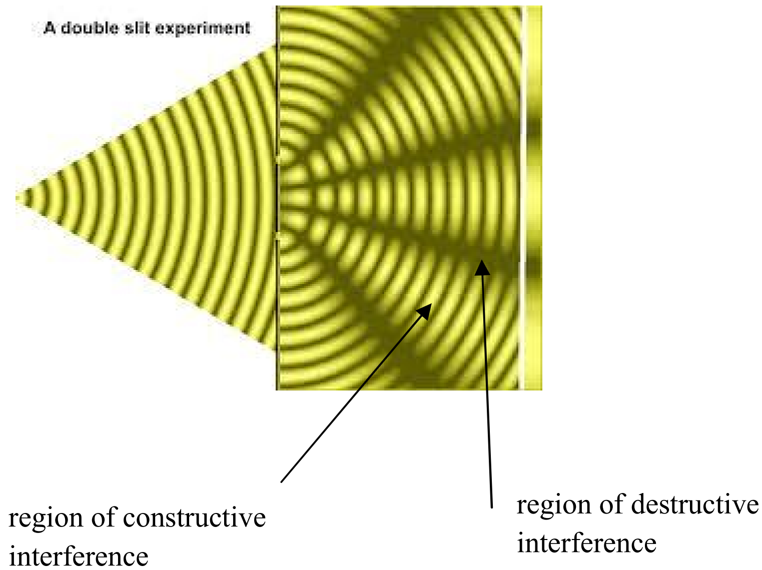


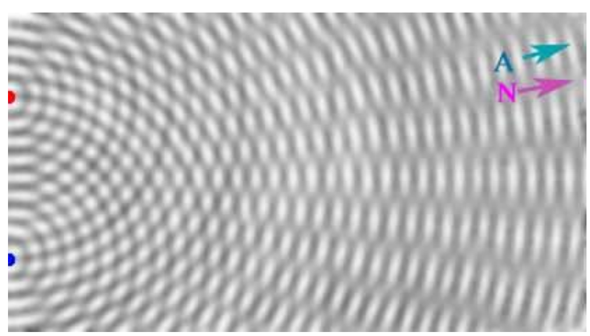
Lines (regions) of constructive interference

According to the new hypothesis, the atom (the electron) of the light source emits weak electromagnetic wave, even before excitation. Therefore, this weak wave is already extended to all the way from the source to the slits and to the detecting screen, even before the atom inside the light source is excited, creating weak wave interference patterns on the screen. Now, when the atom (the electron) is excited, it emits a photon that is a just continuation of (coherent with) the weak wave already being radiated. The emitted photon is not only coherent with the weak precursor wave; *the weak precursor wave and the photon exist as an entity*. We may call this weak wave as the 'precursor' wave. The weak wave, which is now the leading part of the photon to be emitted, serves as the 'highway' for the main photon energy and the photon will land on the screen according to the predetermined (interference) pattern. *The photon will land on the screen according to the weak interference pattern that was formed even before excitation of the atom inside the light source and before emission of the photon*.



With this model of the photon, we can get a more intuitive and logical understanding of the Double-Slit experiments.





This interference pattern formed by the precursor wave is extremely weak . It determines the path of the main energy packet of the photon. In the interference patterns in the figures above, paths to regions of constructive interference can be seen, representing the more probable paths of the photon.

Effect of observation

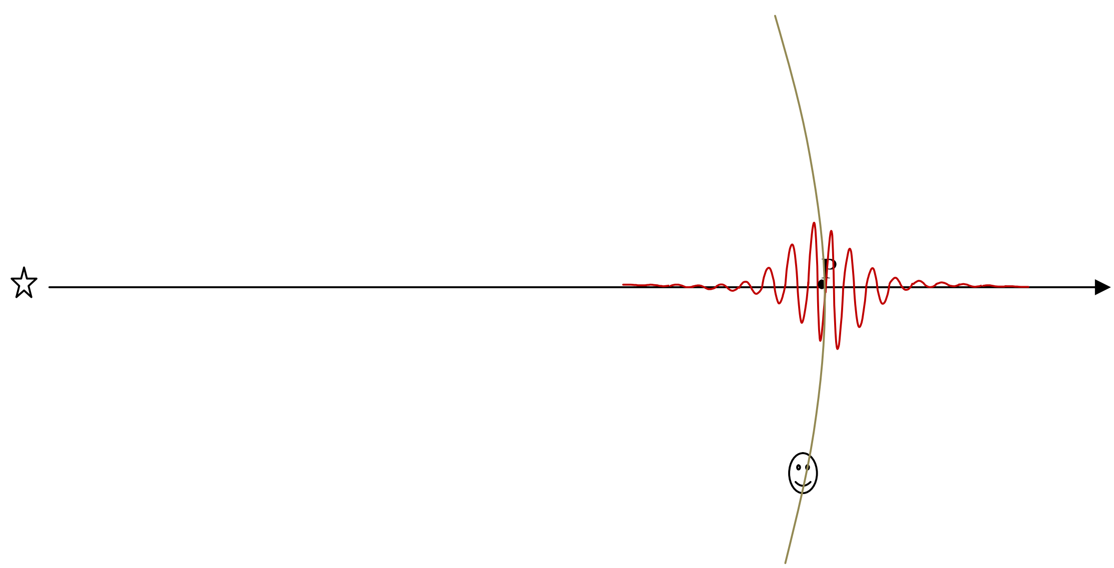
We know the fundamental role of the observer in quantum mechanics. How can an observer affect the result of quantum experiments ?

The effect of the observer in quantum mechanics is related to the collapse of photons at the instance of observation. But why does a photon collapse at the instant of observation ?

The argument we make here is that an atom emits a photon as a whole, which is spatially much more extended as compared to its emitter, the atom. By the principle of reciprocity, therefore, if an atom emits a spatially extended wave packet (the photon), then it should also absorb the spatially extended photon as a whole. This means that the photon, even if it is spatially extended, will 'collapse' to the point of observation.

Photon and electron as entities

As we know, a photon is emitted and absorbed as a whole. To make this clearer, let us think of a puzzle as follows. Imagine a light source and an observer, as shown below.



Suppose that the source emitted a photon along the x-axis. The observer was not on the x-axis when the photon was just passing through point P on the x-axis. Suppose that the observer instantaneously comes to point P, along the wave front. Part of the photon waves have already passed point P. The puzzle is: what will the observer observe ? Will he/she observe only part of the waves before point P, i.e. the waves that haven't yet passed through P ? If the photon can be emitted and absorbed only as a whole, as an entity, then observer P should either detect the photon as a whole or not detect any photon at all. The exact path a photon followed can be determined only after the fact, i.e. only after the photon has been detected. If the observer has detected the photon as a whole, then it must be because the photon has followed the motion of the observer, continuously 'collapsing' to the observer location. It is because the energy of the photon can shift position along the wave fronts instantaneously. Note that the photon energy at the initial location of the observer is non-zero, therefore there is a probability, however small, that the observer can detect the photon even at his initial position.

Therefore, the error in the above argument is that it was based on the conventional assumption that the photon direction of motion had an objective existence, which is not the case.

Another fallacy is that part of the waves of the photon have passed point P. But some observer must confirm that part of the waves have passed point P, who will absorb the whole photon.

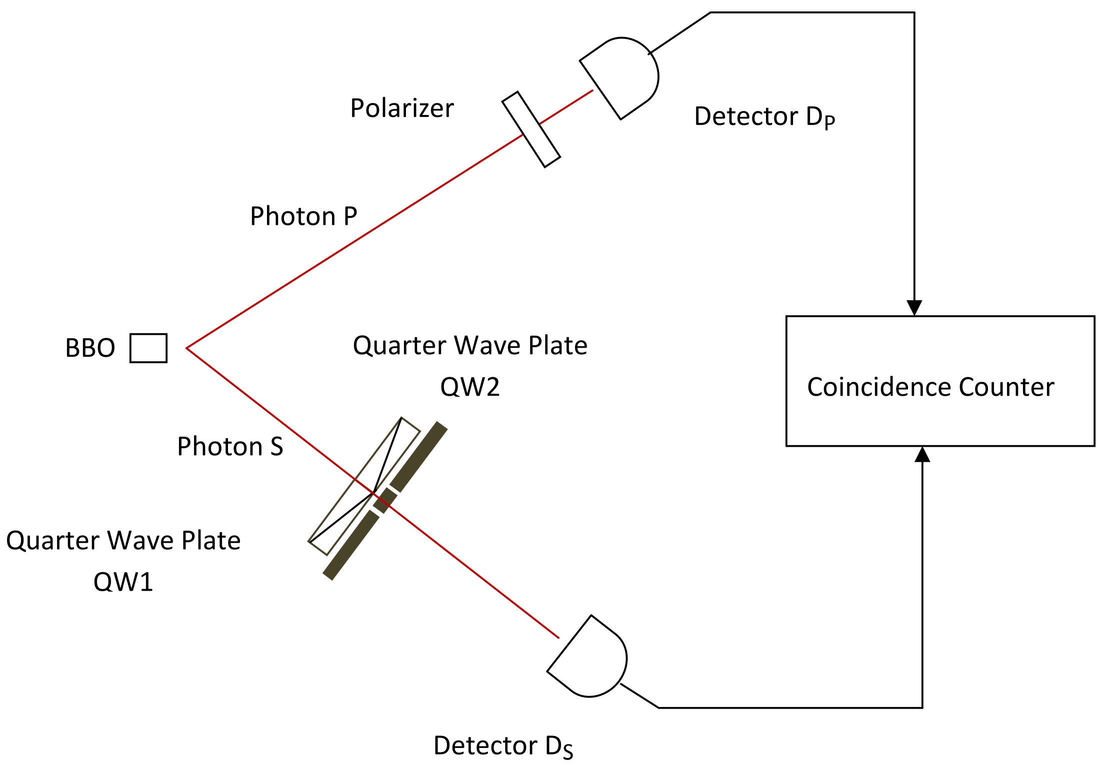
The same law applies for photon emission. A photon is either emitted as a whole or not emitted at all. It is impossible to emit only part of a photon. Suppose that an electron is forced to oscillate and is emitting a photon. Imagine that the force is removed before all the waves comprising the photon have been emitted. But it is believed that a photon can be emitted only as a whole. The solution to this puzzle is that emission of the photon can only be known after the fact: after detection. Applying an accelerating force to the electron only increases the probability of emission of the photon. Moreover, no observer can know that only part of the photon has been emitted.

The fallacy in the above argument is that part of the photon has already been emitted, which requires observation. Since photons can be emitted only as a whole, if part of the photon has been emitted/observed, then the whole photon has already been emitted.

Like photons, electrons also exist as entities.

Quantum Erasure, Which-Way Experiment

Now the Quantum Erasure (Which-Way) experiment will be discussed.



According to the new theory, the atoms and the electrons continuously emit weak waves even before any excitation of the atoms.

Let us first consider the experiment without the polarizers at the slits. An entangled pair of weak waves are continuously emitted by the atoms, even before the atoms are excited. The weak waves create weak interference patterns on the detecting screen. When the atom inside the light source is excited, it emits a photon that is coherent with the weak wave. The photon follows the path of the weak wave and will be detected on the screen according to the pre-formed weak interference pattern.

Now we will consider the case with the polarizers placed in front of the slits. Suppose that the detector D_p detects an X polarized weak wave, before excitation of the light emitting atom. and the detector D_s detected clockwise polarized wave. Then it follows that the wave must have come only through one slit, say the left slit. Now, when the photon is emitted, it lands on the detecting screen according to the bell shaped pattern pre-formed by the weak precursor wave.

It is proposed that detectors D_p and D_s *force* the emitting atom to direct the photon only towards the left slit. Note that the wave *always* passes through both slits, only the amount of energy passing through the left slit is, say 99% of the photon energy. Only 1% of the photon energy passes through the right slit. Since the photon energy passing through the left slit is much larger than that passing through the right slit, there will be no visible interference fringe. The photon emitting atom and the detector atoms interact instantaneously during emission of the photon.

This theory can explain also delayed choice quantum erasure experiments and quantum entanglement. According to this paper, the parameters (polarization, frequency, …) and direction/path of the two entangled photons are determined before or during emission of the photon. Entangled weak waves are continuously emitted and detected before emission of the photons. The entangled photons are emitted according to the already fixed polarizations of the weak waves.

Conclusion

We have proposed a few subtle laws of nature underlying quantum phenomenon that can potentially solve the mysteries of quantum mechanics: 1. what is the medium for the photon wave and for the electron wave ? 2. How can particle interference pattern be explained ? 3. How can observer effect be explained? Two simple ideas can solve these problems: 1. The amplitude of electric and magnetic field of a photon at a given point in its spatial dimension is related to the rate of change of the fields at that point 2. The results of quantum experiments are predetermined even before emission of the photon, because the photon emitter is already emitting a weak, continuous electromagnetic wave (photon) even before excitation of the atom/the electron. When the atom is excited, it emits a photon that is coherent with the weak wave that it had been continuously emitting. The ideas proposed in this paper are not meant to be final and complete, but as possible hints to the final solution.

Thanks to God and His Mother, Our Lady Saint Virgin Mary.

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