

SECTION 9

The Nature of Matter and Light and Resolution of the Problem of Realism

THE PROBLEM

The mechanism of something is the process by which that thing takes place or is brought about. It is a cause of that thing's actions or effects. Quantum Mechanics is in denial of the dependency of effects on prior causes and of the principles of Realism and Locality. That state of denial stems from numerous validated experiments demonstrating various quantum effects conjoined with a total lack of identified causes and mechanisms for the observed behavior.

Such is the overriding problem of Quantum Mechanics, a problem that led Einstein to declare certain quantum behaviors as "spooky".

Furthermore, Quantum Mechanics appears to apply only to the physically very small (the "micro") leaving classical mechanics dealing with the rest of material reality (the "macro"), but with no reason or mechanism for that restriction.

The solution to the problems of Quantum mechanics develops from the wave nature of matter and of light: the oscillatory nature of matter particles' *Spherical-Centers-of-Oscillation* with their *Propagated Outward Flow* developed in Sections 5 and 6 and the dual particle - wave nature of the photon.

For Light, The Photon

Since 1960, when the first laser was made and operated, there have been two different forms of light. The foundations of Quantum Mechanics theory were developed in about 1920. Consequently, all experiments bearing on or cited with regard to Quantum Mechanics effects and for the foundations of Quantum Mechanics theory done before 1960 were experiments done with "natural light" because they preceded the advent of the laser.

"Natural Light" The primary source of light is the transition of an orbital electron of an atom from a "higher" "stable" orbit inward to a less high stable orbit. In *Section 2* it was found that it is impossible for such light to be unitary mono-directional particles and that it is a form of wave. Such light waves are generally of broad wave fronts and tend to spread out in space. They are not spatially limited to a narrow particulate-photon-like lateral dimension able fully to pass through a narrow opening. Per *Section, 2* photons of such light are half-cycle sinusoidal waves in bursts of total energy of $w = h \cdot f$.

"Coherent Light" An important but much less ubiquitous form of light is that generated by a laser. A laser is a device that emits light through optical amplification based on the stimulated emission of electromagnetic radiation. The stimulated emission initially produces the above primary source kind of light but the amplification process results in the light becoming coherent. Coherent light is a beam of photons, particle-like light waves, again half-cycle sinusoidal waves in bursts of energy $w = h \cdot f$, that all have the same frequency and waveform. Only a beam of coherent laser light is able to largely resist spreading and diffusing.

For Matter Particles

In *Section 5* it was found that the form of matter is *Spherical-Centers-of-Oscillation*, spherical oscillations of [1 - Cosine] form. In *Section 6* it was found that The *Spherical-Center-of-Oscillation* consists of a central “core”, a spherical volume of radius $\delta = 4.051,34 \times 10^{-35}$ meters that consists entirely of a high density concentration of the oscillating substance, *Medium*.

What “contains” that core’s supply or why doesn’t it all just quickly “slosh” out and be gone? The answer is that it is trying to do just that, to “slosh” out, as hard as it can. It cannot help propagating outward because it has no container, no physical boundary. But it can only propagate outward at the limiting rate determined by its surface area, $4\pi\delta^2$ and the fastest speed possible for flow, the speed of light, c . It is that flow which mediates the separation distance inherent in the Coulomb Effect, magnetic effects and Gravitation.

In *Section 7* it was found that the forward and rearward wave propagation, as well as the sideward, of a moving *Spherical-Center-of-Oscillation* are different and vary with the velocity of the particle. Those differences carry the information about the state of the particle including its direction, velocity, energy, frequency and mass.

In *Section 8* it was found that the matter wave of particles is a valid actual wave phenomenon that results from the ‘beat’ of the moving *Spherical-Center-of-Oscillation*’s forward wave with it’s rearward.

The intent of this work is not to dispute the numerous Quantum Mechanics experiments conducted and the physical results obtained. Nor is it to criticize attempts to obtain useful physical applications of that behavior such as for example quantum computers.

Rather, the problem of Quantum Mechanics is in the interpretations, the meanings associated with those experiments. It is widely recognized that there is dispute in the science world as to the correct interpretation. The most widely accepted interpretation of the various Quantum Mechanics phenomena is that called “The Copenhagen Interpretation” so named because of its development and advocacy by Neils Bohr and Werner Heisenburg working in the Danish City of Copenhagen.

For an effect, a behavior of nature, to validly demonstrably exist but with no explanation of how or by what mechanism it so exists is simply not acceptable. Without cause and mechanism a phenomenon is by definition *supernatural magic*. It leaves what could hopefully be a useful effect essentially unreliable. It also makes modifying and improving, engineering it more difficult.

The purpose of this work is to investigate of why and how entanglement operates. The effects have the appearance of validly existing therefore, there must be an operative mechanism for it.

RESOLUTION OF THE PROBLEM OF REALISMParticles in Quantum Mechanics

Quantum mechanics postulates that the *state* of every elementary particle can be described by a *wave function*, a mathematical representation from which one can calculate probabilities that the particle is to be found in a particular location or state of motion; and that the act of *measurement / observation* of the particle causes the calculated set of probabilities to *collapse* to the value found by the measurement.

In Quantum Mechanics the condition that, until *measurement / observation*, the specific *state* of the particle is undetermined, consisting of various probabilities of various states according to the *wave function*, is also described as that the particle is in a *superposition* of all of the states.

Realism is the principle that all objects must objectively have a pre-existing value of any of their measurable characteristics independent of any measurement that is made and before the measurement is made. The measurement (observation) cannot and does not create or initiate the value. This means that every material object exists independent of being observed.

But, based upon results like experiment #5 of the Double Slit Experiment, below, Quantum Mechanics' position is that a particle is merely a probability wave function having no material existence until it is "observed". Observation of the particle then causes the wave function to "collapse" to one of the probabilistically superposed states.

What that is telling us is that nothing is real until it has been observed; that we cannot say anything about what things are doing when we are not looking at them; that they do not exist to do anything when we are not looking at them.

This has caused some very well respected cosmologists (*e.g.* Stephen Hawking) concern that this implies that there must actually be something 'outside' the universe to look at the universe as a whole and collapse its overall wave function for the universe to be.

It is not reasonable and is another violation of the principle of Occam's Razor [that the simplest explanation is the most likely] that we should need two different laws to explain the behavior of objects depending on how large or small they are. Why should the laws of cause and effect of the macro world not apply to the micro ?

The following analysis of the Double Slit Experiment resolves these problems. The form of light used in the experiment is important and is a significant factor in the interpretation of results. Consequently the experiment must be analyzed twice: once with the incident light being "natural light" as was certainly the case before the invention of the laser in 1960, and once with the incident light being "coherent light" as in contemporary modern experiments. The "coherent light" case applies for both the incident light being light or particles such as electrons or protons.

The analysis, beginning on the next page, compares the Quantum Mechanics interpretation of each phenomenon with the classical interpretation. It shows that all of the Quantum phenomena are fully explained in terms of classical physics with no need nor involvement of interpretations like the Copenhagen and no "weird behavior" that lacks substantiation by applicable mechanism.

THE DOUBLE SLIT EXPERIMENT - [AS BEFORE 1960]

The incident light is “natural light”. Deeming it to be a particle leads to the “spookiness” and contrary-to- common-sense behaviors. Seeing the photon as the wave it is resolves all of those problems.

Images for the light behaving as waves:

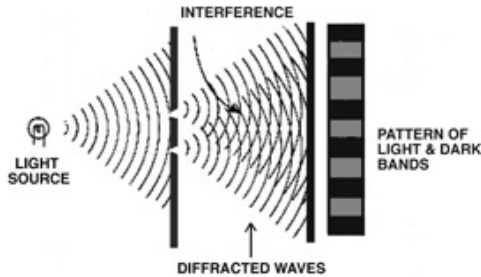


Figure A

Experimental Set-Up and Both Slits Open

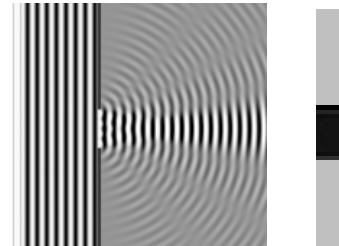


Figure B

Same Set-Up, Only One Single Slit Open

Images for the light behaving as particles:

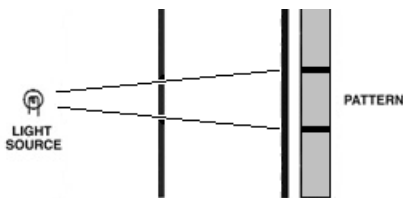


Figure C

Experimental Set-Up and Both Slits Open

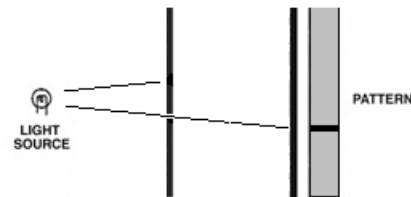


Figure D

Same Set-Up, Only One Single Slit Open

<p><u>Nature of the Propagations</u></p> <p>The light source is “natural light”</p>	<p><u>Quantum Mechanics - Takes Light to be Particulate Photons</u></p> <p>Photons are particle in nature. They do not extend over a broad wave front but rather are analogous to bullets, able to freely pass through narrow slits, and travel in one specific direction. Figure C or D.</p> <p>Their behavior is wave or particle depending on circumstances.</p>	<p><u>Classical Physics Light is “Natural Photons”</u></p> <p>Light is purely wave in nature. The light waves are of broad wave fronts and spread out in space as shown in Figure A. They are not spatially limited to small narrow particles. Encountering a slit the part of the broad wave front at the slit passes through, the rest does not.</p>
<u>The Experiments</u>	<u>Comparison Quantum Mechanics vs. Classical Physics</u>	
<p><i>As Done</i></p> <p>[#1] Light: Continuous Slits: Both open</p> <p><u>Actually Happens</u></p> <p>Wave interference pattern Figure A</p>	<p><u>Quantum Mechanics Interpretation</u></p> <p>[#1] Particulate photons pass through both slits. Their wave behaviors there diffract and interfere making a Figure A effect.</p> <p style="text-align: center; margin-top: 20px;">BELOW “WEIRD BEHAVIOR” IS IN ITALICS</p>	<p><u>Classical Physics Interpretation</u></p> <p>[#1] Part of the broad wave front enters both slits, there diffracts and the results interfere Figure A.</p>

<p><u>As Done</u> [#2] Light: Repeated single photons Slits: Both open [The photons are forced to the one-at-a-time mode by reduction of the light intensity.]</p> <p><u>Actually Happens</u> “Implied” wave interference pattern</p>	<p><u>Quantum Mechanics Photons</u> [#2] We would expect a single photon to go through one slit or the other Figure C; it cannot go through both at the same time to create an interference pattern. Rather the expectation is a Figure C spot opposite each slit. But what we get is an “implied” interference pattern as Figure A.</p> <p><i>It is as if each individual photon “knows” that both slits are open even though it passes through only one.</i></p> <p><i>And it will place itself on the screen such that when enough have passed through they have built up an implied interference pattern, in spite of that there cannot possibly be any actual interference of the one-at-a-time photons.</i></p>	<p><u>Classical Physics Interpretation</u> [#2] The single photon aspect is the same broad wave front with the waves in single bursts of $W = h \cdot f$.</p> <p>The light waves are at broad wave fronts not spatially limited to small particles like the photons. The broad wave front passes both slits, and the results interfere as Figure A.</p>
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<p><u>As Done</u> [#3a] Light: Repeated single photons Slits: One open, one closed</p> <p><u>Actually Happens</u> The photons cluster around points on the detector screen behind the open slit Figure D there being no 2nd wave to interfere with.</p> <p>[3b] But, if the second slit is opened</p> <p><u>Actually Happens</u> The photons immediately start to form an “implied” interference pattern as in [#2] Figure A.</p>	<p><u>Quantum Mechanics Photons</u> [#3a] We expect a single photon to go through one slit or none. The expectation is a Figure D spot opposite the open slit and that is what happens.</p> <p>[#3b] <i>But, an individual photon passing through one of the slits is not only aware of the other slit, but also is aware of whether or not it is open.</i></p> <p><i>If the closed other slit is opened it immediately reverts to the [#2] situation Figure A.</i></p> <p><i>It is as if each individual photon “knows” that both slits are open or that just one slit is open even though it passes through only one and doesn’t visit the other to test it, and it will place itself on the screen in such a position that when enough have passed through they have collectively built up an interference pattern, in spite of that there cannot possibly be any actual interference of the one-at-a-time photons.</i></p>	<p><u>Classical Physics Interpretation</u> [#3a] The light waves are at broad wave fronts not spatially limited to small particles like the photons. They enter the open slit and produce a spot as in Figure B.</p> <p>[#3b] If the closed slit is opened the broad wave front enters both slits, there diffracts and the results interfere.</p> <p>The one-at-a-time aspect is the same broad wave front with the waves in single bursts of $W=h \cdot f$.</p>
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<u>As Done</u>	<u>Quantum Mechanics Photons</u>	<u>Classical Physics Interpretation</u>
<p>[#4a] Light: Repeated single photons Slits: Both open Detectors at both slits [Detectors observe which slit a photon goes through but let it pass on to the screen.]</p> <p><u>Actually Happens</u> The pattern of Figure C, a spot opposite each slit with no interference pattern.</p> <p>[#4b] Remove the detectors</p> <p><u>Actually Happens</u> Reverts to [#3b] The photons immediately start to form an "implied" interference pattern as in [#2] Figure A.</p>	<p>[#4a] Because of the one-at-a-time single photons a photon can only go through one slit or the other. There will never be a pair of photons at the same time. Thus there can never be "real" interference.</p> <p><i>Being "observed" the photons are forced to collapse to particulate form unable to form an implied interference because of not being waves but particles..</i></p> <p>[#4b] We expect a single photon to go through one slit or the other Figure C; it cannot go through both at the same time to create an interference pattern. The expectation is a Figure C spot opposite each slit. But what we get is an "implied" interference pattern as Figure A.</p> <p><i>It is as if each individual photon "knows" that both slits are open even though it passes through only one. And it will place itself on the screen in such a position that when enough have passed through they have collectively built up an implied interference pattern, in spite of that there cannot possibly be any actual interference of the one-at-a-time photons.</i></p> <p>[#4a] & [#4b] <i>The photons "know" whether the detectors are present or not. They adjust their behavior accordingly.</i></p>	<p>[#4a] The one-photon-at-a-time light propagation has the same broad wave front as Figure A not the narrowness of a "bullet like" photon. The reduced intensity wave front (reduced to produce single photons) arrives in single bursts of energy $W=h \cdot f$ with periods of non-wave separating successive bursts. Each burst is a half cycle of an electromagnetic sinusoid as in "Analysis of the Photon from Its Generating Source" in Section 2.</p> <p>#4a] & [#4b] In detecting a part of a wave burst passing through its slit the detector there unavoidably slightly delays that part of the burst's wave front.(see * below).</p> <p>The result is: [a] A reported detection and [b] The delayed part of the burst proceeds from its detector to the screen alone without interference. [c] The absence of interference is because the portion of the burst's overall wave front that passes the other slit does so at a different time than at the first slit because of the slight time difference in the burst's delay at the other slit's detector. (see * below).</p> <p>With that action because of the non-identical detectors a wave passes on from its slit at a time that that is not happening at the other slit making each slit the case of Figure B, the wave version of Figure C.</p> <p>It is the process of detection and its time delay variation that produces the change from the interference patterns to "spots".</p> <p>[#4b] With the detectors removed the two slits wave bursts are again synchronized and interfere.</p>

<u>As Done</u>	<u>Quantum Mechanics Photons</u>	<u>Classical Physics Interpretation</u>
<p>[#5a] Light: Repeated single photons Slits: Both open Detector at just one of the two slits</p> <p><u>Actually Happens</u> The pattern of Figure C, a spot opposite each slit with no interference pattern.</p> <p><u>As Done</u> [#5b] Light: Repeated single photons Slits: Both open No detectors</p> <p><u>Actually Happens</u> An “implied” interference pattern as in Figure A</p>	<p>[#5a] & [#5b] <i>If a photon passes through a slit that does not have a detector, it not only “knows” if the other slit is open or not, it “knows” if the other slit is being observed.</i></p> <p><i>If there is no detector at the other slit as well as the one it is passing through, it will produce a Figure A interference pattern.</i></p> <p><i>Otherwise it will act as a Figure C particle.</i></p> <p><i>This is a specific example of the interaction of the observer with the experiment. If we try to observe the action, it collapses into a definite particle, but when we do not observe it opts between wave and particle depending on the situation at the other slit, which it “knows”.</i></p> <p><i>The “collapse of the wave function” theory seeks to explain how an entity such as a photon or an electron, could ‘travel as a wave but arrive as a particle’. The theory proposes that what passes through the slits is not a material wave nor particle but a “probability wave”.</i></p> <p><i>In this theory, an electron or photon that is not being observed does not exist as a particle at all, but has a wave-like property covering the areas of probability where it could be found.</i></p> <p><i>Once the electron or photon is observed, the wave function is forced to collapse because the various probabilities have become something definite; the electron or photon becomes a particle.</i></p>	<p>[#5a] & [#5b] The same as for #4, above. The effect of just one detector at one slit produces the timing separation delays that prevent the flow through both slits jointly interfering in the same fashion as with detectors at both slits.</p>
<p>Note: Experiment #5 is identical to #4 except in #4 there are detectors at both slits and in #5 a detector at just one slit.</p>		<p>*A detector cannot avoid causing modification of that which it detects, delaying or changing it in some manner. Furthermore, no two detectors will do so identically. The difference need merely be the wave burst’s half-period.</p> <p>The half period of visible light is in the range of 10^{-5} m. At the speed of light, $3 \cdot 10^8$ m/s the delay needed to separate the bursts at the two slits is a delay on the order of 10^{-14} s. Much greater delays and variations in that amount are to be expected from the detectors</p>

THE DOUBLE SLIT EXPERIMENT - [AS AFTER 1960]

The incident light is laser-generated "coherent light".

Images for the light behaving as waves:

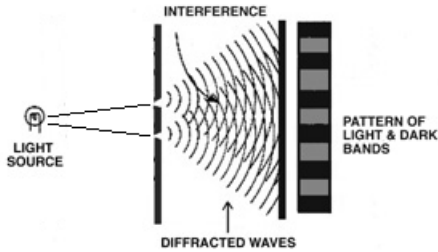


Figure A

Experimental Set-Up and Both Slits Open

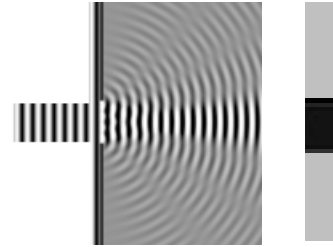


Figure B

Same Set-Up, Only One Single Slit Open

Images for the light behaving as particles:

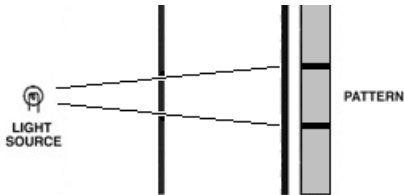


Figure C

Experimental Set-Up and Both Slits Open

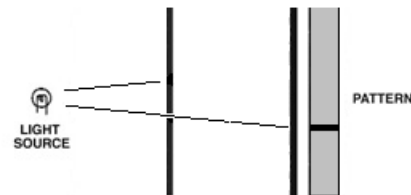


Figure D

Same Set-Up, Only One Single Slit Open

<p><u>Nature of the Propagations</u></p> <p>The light source is "coherent light"</p>	<p><u>Quantum Mechanics - Takes Light to be Particulate Photons</u></p> <p>Photons are particle in nature. They do not extend over a broad wave front but rather are analogous to bullets, able to freely pass through narrow slits, and travel in one specific direction. Figure C or D.</p> <p>Photons exhibit a combination of wave behavior or particle behavior depending on the circumstances.</p>	<p><u>Classical Physics - Light is Collimated "Natural Photons"</u></p> <p>Light is a stream of half-cycle sinusoidal bursts of energy $W = h \cdot f$.</p> <p>The initially multi-directional bursts are focused into a narrow Collimated stream as if a particle.</p>
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<u>The Experiments</u>	<u>Comparison Quantum Mechanics vs. Classical Physics</u>	
<p><i>As Done</i></p> <p>[#1] Light: Continuous single photons</p> <p>Slits: Both open</p> <p><u>Actually Happens</u></p> <p>Wave interference pattern Figure A</p>	<p><u>Quantum Mechanics Interpretation</u></p> <p>Particulate photons pass through both slits. Their wave behaviors diffract and interfere as shown [Figure A].</p> <p style="text-align: center;">BELOW "WEIRD BEHAVIOR" IS IN ITALICS</p>	<p><u>Classical Physics Interpretation</u></p> <p>Half-cycle sinusoidal bursts pass through both slits. Their waves diffract and interfere as shown [Figure A]</p>

<p><u>As Done</u> [#2] Light: Repeated single photons Slits: Both open</p> <p><u>Actually Happens</u> “Implied” wave interference pattern</p>	<p><u>Quantum Mechanics Photons</u> We would expect a single photon to go through one slit or the other Figure C; it cannot go through both at the same time to create an interference pattern. Rather the expectation is a Figure C spot opposite each slit. But what we get is an “implied” interference pattern as Figure A.</p> <p><i>It is as if each individual photon “knows” that both slits are open even though it passes through only one.</i></p> <p><i>And it will place itself on the screen such that when enough have passed through they have built up an implied interference pattern, in spite of that there cannot possibly be any actual interference of the one-at-a-time photons.</i></p>	<p><u>Classical Physics Interpretation</u> The half-cycle sinusoidal bursts are diffracted at their slits. Again just as with the waves of the “natural light” Figure A, the diffracting spreads out the wave front destroying the coherence.</p> <p>Depending on where on the slit encounters where on the half-cycle sinusoid the new directions of the diffracted sinusoids vary.</p> <p>Successive bursts achieve simultaneity by the sideward diffracted wave from one slit arriving at the other slit when that other is passing a burst.</p> <p>Successive various diffracted sinusoids mark out an interference pattern on the screen.</p>
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<p><u>As Done</u> [#3a] Light: Repeated single photons Slits: One open, one closed</p> <p><u>Actually Happens</u> The photons cluster around points on the detector screen behind the open slit Figure D.</p> <p><u>As Done</u> [3b] But, if the second slit is opened</p> <p><u>Actually Happens</u> The photons immediately start to form an “implied” interference pattern as in [#2] Figure A.</p>	<p><u>Quantum Mechanics Photons</u> [#3a] We expect a single photon to go through one slit or none. The expectation is a Figure D spot opposite the open slit and that is what happens.</p> <p>[#3b] <i>But, an individual photon passing through one of the slits is not only aware of the other slit, but is aware of whether or not it is open.</i></p> <p><i>If the closed other slit is opened it immediately reverts to the [#2] situation Figure A.</i></p> <p><i>It is as if each individual photon “knows” that both slits are open or that just one slit is open even though it passes through only one and doesn’t visit the other to test it, and it will place itself on the screen in such a position that when enough have passed through they have collectively built up an interference pattern, in spite of that there cannot possibly be any actual interference of the one-at-a-time photons.</i></p>	<p><u>Classical Physics Interpretation</u> [#3a] Each half-cycle sinusoid behaves at the open slit analogously to Figure B.</p> <p>[#3b] Reverts to [#2]</p>
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<u>As Done</u>	<u>Quantum Mechanics Photons</u>	<u>Classical Physics Interpretation</u>
<p>[#4a] Light: Repeated single photons Slits: Both open Detectors at both slits [Detectors observe which slit a photon goes through but let it pass on to the screen.</p> <p><u>Actually Happens</u> The pattern of Figure C, a spot opposite each slit with no interference pattern.</p>	<p>[#4a] Because of the one-at-a-time single photons a photon can only go through one slit or the other. There will never be a pair of photons at the same time. Thus there can never be "real" interference.</p> <p><i>Being "observed" the photons are forced to collapse to particulate form unable to form an implied interference because of not being waves but particles..</i></p>	<p>#4a] & [#4b] In detecting a wave burst passing through its slit the detector there unavoidably slightly delays it.(see * below).</p> <p>The result is: [a] A reported detection and [b] The delayed burst proceeds from its detector to the screen alone without interference.</p>
<p><u>As Done</u> [#4b] Remove the detectors</p> <p><u>Actually Happens</u> Reverts to [#3b] The photons immediately start to form an "implied" interference pattern as in [#2] Figure A.</p>	<p>[#4b] We expect a single photon to go through one slit or the other Figure C; it cannot go through both at the same time to create an interference pattern. The expectation is a Figure C spot opposite each slit. But what we get is an "implied" interference pattern as Figure A.</p> <p><i>It is as if each individual photon "knows" that both slits are open even though it passes through only one. And it will place itself on the screen in such a position that when enough have passed through they have collectively built up an implied interference pattern, in spite of that there cannot possibly be any actual interference of the one-at-a-time photons.</i></p>	<p>[c] The absence of interference is because the burst that passes the other slit does so at a different time than at the first slit because of the slight time difference in the burst's delay at the other slit's detector. (see * below).</p> <p>With that action because of the non-identical detectors a wave passes on from its slit at a time that that is not happening at the other slit making each slit the case of Figure B, the wave version of Figure C.</p>
	<p>[#4a] & [#4b] <i>The photons "know" whether the detectors are present or not. They adjust their behavior accordingly.</i></p>	<p>It is the process of detection and its time delay variation that produces the change from the interference patterns to "spots".</p> <p>[#4b] With the detectors removed the two slits wave bursts are again synchronized and interfere.</p>

<u>As Done</u>	<u>Quantum Mechanics Photons</u>	<u>Classical Physics Interpretation</u>
<p>[#5a] Light: Repeated single photons Slits: Both open Detector at just one of the two slits</p>	<p>[#5a] & [#5b] <i>If a photon passes through a slit that does not have a detector, it not only “knows” if the other slit is open or not, it “knows” if the other slit is being observed.</i></p>	<p>[#5a] & [#5b] The same as for #4, above. The effect of just one detector at one slit produces the timing separation delays that prevent the flow through both slits jointly interfering in the same fashion as with detectors at both slits.</p>
<p><u>Actually Happens</u> The pattern of Figure C, a spot opposite each slit with no interference pattern.</p>	<p><i>If there is no detector at the other slit as well as the one it is passing through, it will produce a Figure A interference pattern.</i> <i>Otherwise it will act as a Figure C particle.</i></p>	
<p><u>As Done</u> [#5b] Light: Repeated single photons Slits: Both open No detectors</p>	<p><i>This is a specific example of the interaction of the observer with the experiment. If we try to observe the action, it collapses into a definite particle, but when we do not observe it opts between wave and particle depending on the situation at the other slit, which it “knows”.</i></p>	
<p><u>Actually Happens</u> An “implied” interference pattern as in Figure A</p>	<p><i>The “collapse of the wave function” theory seeks to explain how an entity such as a photon or an electron, could ‘travel as a wave but arrive as a particle’. The theory proposes that what passes through the slits is not a material wave nor particle but a “probability wave”.</i></p>	
<p>Note: Experiment #5 is identical to #4 except in #4 there are detectors at both slits and in #5 a detector at just one slit.</p>	<p><i>In this theory, an electron or photon that is not being observed does not exist as a particle at all, but has a wave-like property covering the areas of probability where it could be found.</i></p> <p><i>Once the electron or photon is observed, the wave function is forced to collapse because the various probabilities have become something definite; the electron or photon becomes a particle.</i></p>	<p>*A detector cannot avoid causing modification of that which it detects, delaying or changing it in some manner. Furthermore, no two detectors will do so identically. The difference need merely be the wave burst’s half-period.</p>
		<p>The half period of visible light is in the range of 10^{-5} m. At the speed of light, $3 \cdot 10^8$ m/s the delay needed to separate the bursts at the two slits is a delay on the order of 10^{-14} s. Much greater delays and variations in that amount are to be expected from the detectors</p>

Examining in the above tables the right two columns, “Quantum Mechanics Photons” [QM] and “Classic Physics Interpretation” [CP], the QM is quite complex and the CP is simple. In the QM column the comments in italics are all various instances of unsound, unscientific, un-validated Quantum “weirdness” contentions. In every case the CP column provides a sound classical scientific analysis of the behavior.

Of note is that CP uses none of and QM depends on use of unscientific and un-validated descriptions referring to a photon being in some sense aware of states and events beyond its ken, it having consequent options and the ability to choose between them, and doing such things while not really existing until it subsequently is ‘collapsed’ by being ‘observed’.

In particular the QM description and analysis of what is going on requires the particle to be in the form of a probability wave function until its being “observed” collapses it to a specific state. That the CP explains the behavior without any of that speculative and unsupported-by-evidence Copenhagen interpretation demonstrates the non-validity of the Copenhagen interpretation and similar other interpretations.

THE DOUBLE SLIT EXPERIMENT WITH MATTER PARTICLES INSTEAD OF PHOTONS

In Section 8 it was shown that every matter particle, that is every Spherical-Center-of-Oscillation, emits oscillatory Propagated Outward Flow radially in all directions and when in motion is accompanied by an oscillatory matter wave so that for the purposes of these experiments those matter particles are equivalent to coherent photons. All of the Double Slit phenomena presented derive from and are applicable to the Quantum behavior of matter particles.

CONCLUSION OF THE PROBLEM OF REALISM

1 – In brief, CP makes sense and QM seems like *supernatural magic* in: supplying no cause nor mechanism for its contended superposition of states, nor for its particles existing only as a probability wave function, nor for the particles’ change from probability to specific existence initiated by an act of observation in some form, and nor for the particles having unexplainable knowledge about events and conditions physically beyond their ken.

2 – The above analysis of the Double Slit Experiment demonstrates that particles that can exist do so whether observed, measured or not. They exist not as wave functions having material reality only when collapsed by being observed but as not-a-problem Realism’s *Spherical-Centers-of-Oscillation* propagating their *outward flow*.

3 – The Copenhagen and similar interpretation of particles being only a wave function before existence upon being observed fails as:

- [a] not necessary to explain or account for phenomena, as shown above by CP, and
- [b] unscientific and unsound in that it lacks any cause or mechanism for the behavior.

4 – Wherefore: the classical principle of Realism is sustained.

Particle Centers-of-Oscillation and Quantum Mechanics

Because *Spherical Centers-of-Oscillation* oscillate over a cyclic range of instantaneous values per the particular *[1 – Cosine]* waveform of each case, the *state* of the particle can be thought to so continuously vary cyclically. That would be analogous to the Quantum Mechanics “*state*” of the particle as the particular instantaneous position in its wave function as analogous to the particular instantaneous position that its *Spherical Centers-of-Oscillation* is at a particular moment.

- The waveform of the *Spherical Centers-of-Oscillation* would be the “*wave function*” of Quantum Mechanics.

- The *Spherical Centers-of-Oscillation*'s oscillation over its range of instantaneous values would be the Quantum Mechanics described behavior that particles are in a *superposition of all possible states* until a *measurement / observation* causes the *superposition* to *collapse* to the state *measured / observed*.

- Of course the particle's oscillation is in only one pure, single, simple, state, point in its cyclic oscillation at any moment not simultaneously in all possible states as the Quantum Mechanics contention implies;

- The *collapse* would be the selection of that particular instantaneous position of the waveform of the *Spherical Centers-of-Oscillation* that it happens to occupy at the instant of the *measurement / observation*.

■ - However none of that means anything like the imaginative Quantum Mechanics' non-existence of the particle until it is actually observed.

REALITY AND REALISM

Developments in the progress of physics must always pass two tests.

The first test is the test of standing up to examination in terms of the real world in which our reality exists. That requirement applies equally to the evaluation and interpretation of material experiments, of "thought experiments" and to the related mathematics.

For example:

The electrons flowing in copper wires are atomic level particles that according to Quantum Mechanics' denial of Realism should be represented only by their wave functions until they are observed [measured]. That means that all electrical activity must be null until its collapse into existence. Every day experience shows that that is not the case.

It may be contended that all electrical activity is in fact always observed or measured by producing the effect or action that it was designed to do and is operated to do. But, can that be true of the device pilot light that is on all night when no one knows, sees, or cares?

And, if "yes the wave function and collapse principle includes even that", then while the principle can be deemed valid if one so wishes it would be a *reductio ad absurdum* in that everything is now and always observed and therefore collapsed.

Quantum Mechanics' denial of Realism fails the test of real world reality.

The second test is mechanism. For particles to be solely a "superposition of all of the possible states of the particle" and then a "collapse to the specific state measured" there must be a cause of both the superposition and of the reversion to one particular specific state, there must be a mechanism to account for each.

Again, Quantum Mechanics denial of Realism fails the test of supporting cause and mechanism.

