

SECTION 3

The Effect of the Necessity of Causation On Quantum Mechanics

The beginnings of Quantum Mechanics, that is the scientific effects that underlay the introduction of quantization, were: black body radiation from a material's heat energy, the photoelectric effect, and the line spectra of gases as related to the electron orbital model of the atom.

The first indication of quantization in the material universe was in Planck's solution to the problem of black body radiation. Planck found that the only way to reconcile a severe mis-match [Rayleigh Jeans Law] of theory to experimental observation of black body radiation was to drop the concept of a smooth continuous flow of radiation energy [heat] from a radiating body replacing it with the concept of the heat energy becoming distinct packets of energy each of an amount equal to the product of the frequency, f , of the [infra red - visible - uv] radiation and a constant, h , subsequently named the "Planck Constant" as $W = h \cdot f$. In Planck's analysis there was no treatment as to how that quantization takes place, its cause. It was only an issue of what the radiation consisted of. However Planck's analysis was of the energy exchange from its appearing as heat temperature in the black body to its being emitted as heat radiation.

Then Einstein in seeking to find an explanation for the photoelectric effect extended Planck's concept into that of the radiation traveling away from the black body as distinct particles, packets of $W = h \cdot f$. Per Planck the radiation was conceptually a wave propagating outward. Einstein introduced the idea of the radiation traveling outward as distinct particles, subsequently named "photons".

Then Bohr's analysis addressing the discrete line spectra of atoms and the relation to stable electron orbits of the atom demonstrated that the orbital electrons' orbits were restricted to a limited number of discrete "stable" orbits for which the angular momentum was an integer multiple of the Planck Constant divided by 2π as below.

$$(3-1) \quad m \cdot v \cdot R = n \cdot \frac{h}{2\pi} \quad [n = 1, 2, \dots]$$

As with the classical treatment for black body radiation and for the photoelectric effect, the classical treatment for stable electron orbits and atomic line spectra provided no causation, in this case no cause for the angular momentum to be quantized.

Those defects are here now further below resolved by the following cause-based analyses for black body radiation, the photon and the photoelectric effect, and the line spectra of gases as related to the electron orbital model of the atom.

STEP 1 – BLACK BODY RADIATION

The heat energy in a black body, the heat energy corresponding to the material's temperature resides in the vibratory oscillatory motion of the atoms of the material which are continuously oscillating, vibrating. The heat energy corresponding to the material's temperature exists as the vibratory oscillations of its atoms about their average neutral [*temperature = 0° Kelvin*] positions. In the material the atoms' average positions are bound their by the neighboring atoms.

Every oscillation that we know in nature exhibits, and the very theory of oscillations in the abstract requires, that the oscillation consist of two aspects storing and exchanging the energy of the oscillation back and forth. (With one aspect varying in oscillatory fashion then when that aspect decreases there must be some "place" for its energy to go, a place in which it is stored until it reappears in that aspect when it increases again. It cannot completely disappear or be lost because the oscillation would die. That "place" is the oscillation's second aspect and it obviously must vary in a manner related to the first aspect's variation, but with its energy storage in opposite phase.

A pendulum, an example by analogy, oscillates by the motion of its swinging mass between peak height in the gravitational field (potential energy) at each end of the swing and peak speed of motion (kinetic energy) at the mid-point between the ends of the swing. Such is the nature of the oscillations of the atoms in a black body.

A material body's thermal expansion with increase in temperature is due to the increased amount of energy [heat] in the material, and the consequent increase in the amplitude of the atoms' vibrations. There is a continuous flow of the heat energy in the body from warmer parts to cooler ones, a seeking of temperature uniformity. In addition there is a continuous flow of heat energy from the ambient environment tending to increase the temperature and a continuous flow of heat energy from the black body outward to its environment as follows..

– *THE QUANTIZATION OF BLACK BODY RADIATION.*

The oscillating atom is in a cavity which is the location of the atom as constrained by the surrounding atoms. The oscillating atom is an electrically charged oscillator in its cavity. Its motion is a changing electric field and its motion generates a changing magnetic field. That oscillating electromagnetic

(E-M) field propagates outward from its “antenna”, which is the oscillating atom, just as radio waves propagate their (E-M) energy outward from their antenna,

While that (E-M) field propagation outward from the oscillating atoms of the black body is exactly the same process as the transmission or broadcasting of (E-M) field from radio stations’ antennae, there is one important exception. For the radio stations the energy propagated is smoothly and continuously replaced by further (E-M) energy, matching that which was just radiated, flowing from the station to the antenna. The propagated field is continuous.

But there is no such smooth continuous flow of new energy to an atom to replace its having expended its oscillation energy in a single half-cycle of propagated (E-M) field; The atom’s propagated field is a single burst of energy, not a continuous flow. The atom is randomly re-energized by the exchange of energy throughout the atom’s piece of material but not smoothly continuously. Each re-energization is of a different amount of energy corresponding to a different frequency at the next radiation burst.

A 56 gram piece of iron contains approximately $6 \cdot 10^{23}$ atoms. Even if as few as one out of every trillion were to propagate its burst of (E-M) radiation at the same time that would still be $6 \cdot 10^{11}$ such propagations collectively appearing as a smooth continuous (E-M) field in spite of being a collective vast number of individual bursts

In the context of the black body and its environment there are continuous propagating (E-M) fields originating at atoms of the black body and encountering the black body from its surrounding environment. Each atom continuously propagates and is re-excited as it receives propagation. The outward propagating (E-M) field is the “black body radiation”.

Its frequency is determined by the wavelength that corresponds to the energy in the source atom’ oscillation. Its energy is the energy of that particular atom’s oscillation energy. All of the other atoms of the black body are involved and doing the same kind of propagation and re-excitation; however, each atomic propagation is a separate event.

In 1900, German physicist Max Planck heuristically derived a formula for the observed measured spectrum of black body radiation by assuming that a hypothetical electrically charged oscillator in a cavity that contained black-body radiation could only change its energy in a minimal increment that was proportional to the frequency of its associated (E-M) wave.

Planck’s derivation is a description of the above black body behavior. There is nothing in it calling for specific particle-like photons being propagated. There is only the Maxwell’s equations described (E-M) field propagated by oscillating electric charge in separate bursts.

Myriad such (E-M) bursts are continuously propagated from their myriad sources, individual atoms. Collectively the pattern of their variation with temperature and their various wavelengths (and, therefore, frequencies, and, therefore energies $W = h \cdot f$) are as Figure 3-1, on the following page.

The appearance of quantization is merely the effect of the black body's atoms being unable to sustain continuous propagation because their re-energization is not smooth and continuous.

It is not a special quantum effect; it is only classical particles operating classically.

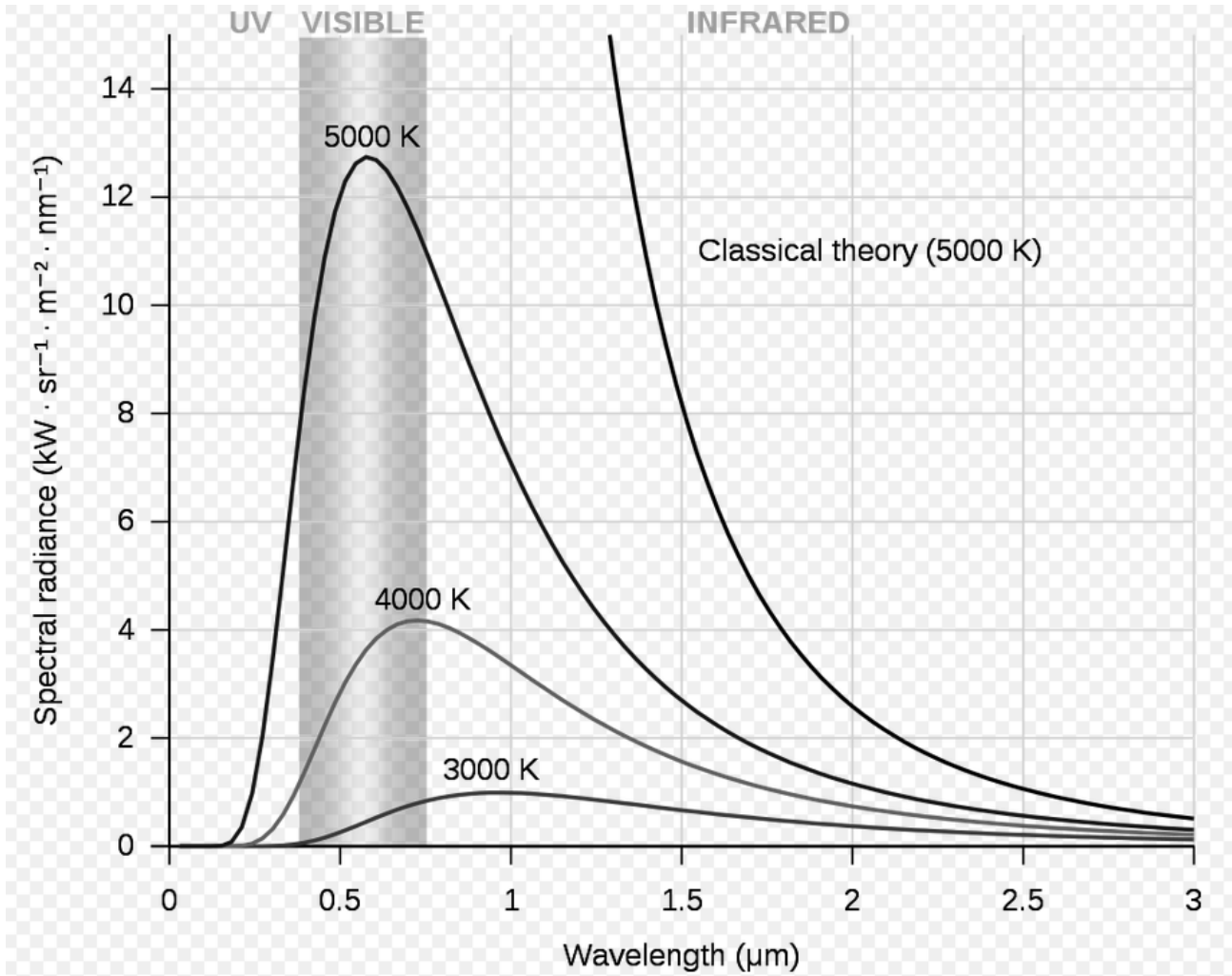


Figure 3-1 – Black Body Radiation

STEP 2 – THE PHOTOELECTRIC EFFECT

Einstein in seeking an explanation for the photoelectric effect extended Planck's concept into that of the radiation traveling away from the black body as distinct particles. For Planck the radiation was conceptually a wave propagating outward. Einstein introduced the idea of the radiation traveling outward as distinct particles, subsequently named "photons".

Einstein's Photoelectric Effect

Under suitable circumstances, it is found that when light or other (E-M) radiation of sufficiently high frequency shines on or encounters a material substance then electrons are given off by the substance. This *photoelectric effect* is the operating principle of television cameras, xerographic copiers, etc.

The normal expectation would be that one would have to wait a shorter or longer time, depending on the intensity of the light, while it delivers enough energy to free the electrons, a heating up period so to speak. On that basis any (E - M) radiation should produce some electrons from the substance that it encounters if given enough time.

But, that mode of behavior is not the case. Experimental observations show that there is no heating up time, no apparent energy accumulation. Electrons are liberated by the incident light immediately if they are to be liberated at all.

But, there is a threshold frequency below which the light never releases electrons, at and above which electrons are always released, and at and above which the rate at which electrons are given off depends on the light intensity. The threshold frequency is different for different substances on which the light is shined. Furthermore, the electrons are given off with various individual energies, but the maximum energy of the released electrons depends directly on the light frequency. Figure 3-2, below, depicts this photoelectric effect behavior for different substances.

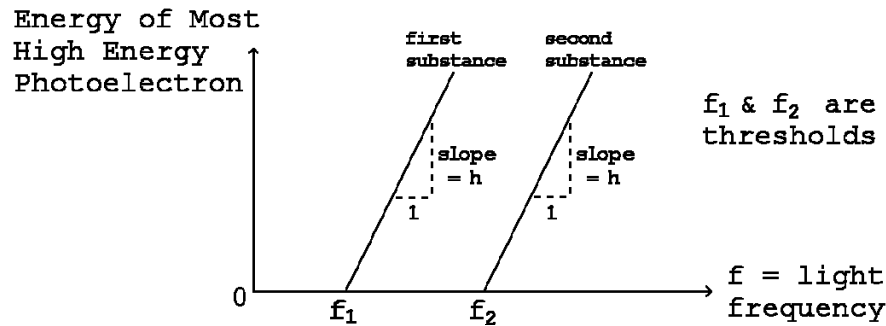


Figure 3-2

The slope of all such lines turns out to be the same, as depicted above. (The slope is the amount the line rises per unit horizontal change.) Furthermore, the slope turns out to have the same value as Planck's constant, h , the constant that Planck found necessary to explain black body radiation.

Einstein explained this behavior by postulating, similarly to Planck's assumption for black body radiation, that the light travels in packets of energy each containing the energy $W = h \cdot f$. These packets of light energy were given the name *photons*. Einstein's hypothesis was that if a photon that is part of the incident light and that encounters an electron in the substance has enough energy W due to its frequency f so that the photon energy is greater than the energy binding the electron into the substance, then the electron will be released.

Photons at frequencies below that threshold would not have enough energy to free an encountered electron. A photon of energy greater than the threshold would not only release the electron but would impart to it its excess energy as kinetic energy. The rate of electrons release would depend on the rate of photons with time, which corresponds to the intensity of the light. released.

That beautiful photoelectric effect theory of Einstein [for which he was awarded a Nobel Prize] has only one problem, there is no such photon, as follows.

THE PROBLEM OF THE PHOTON

Light exhibits behavior only explainable as an electromagnetic (E-M) wave yet light also exhibits behavior that would appear to be only explainable as it being of particle nature. The evidence for the wave nature of light is the wave behaviors of: reflection, interference, refraction, diffraction, frequency, wavelength, polarization, and the highly successful Maxwell's Equations

The phenomena that require a particle nature of light were the failure at short wavelengths of the theoretical Rayleigh-Jeans law [see above] of black body radiation, the photoelectric effect, and the line spectra of gases. This evidential

wave-particle duality led to the concept of the photon as a particle in the form of a “wave packet”. But, the particle photon still has a number of problems.

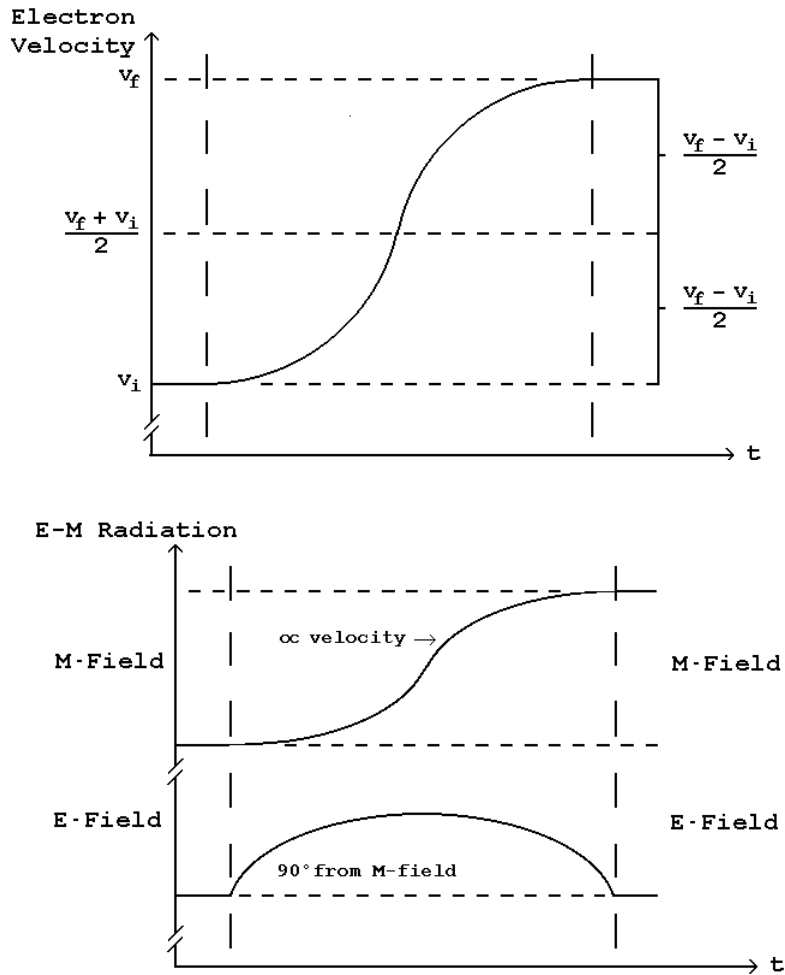
A wave in free space spreads out as it propagates, but the particle photons must stay together like a particle. The (E-M) wave front is continuous, but a front of propagating particles has the particles' moving radially from the source, the distance between particles increasing with distance and nothing in the spaces between them.

(E-M) radiation is produced by acceleration of charge and must produce (E-M) propagation that is spatially symmetrical to the charge's motion, but the particle theory requires that the radiation travel away from the accelerated charge in some specific direction. The next particle may be in another direction, the next in a third, so that a large number of particles exhibit a dispersion pattern like that of a wave field, but that still is behavior that is inconsistent with the wave aspect.

ANALYSIS OF THE PHOTON FROM A GENERATING SOURCE

To resolve this problem we go to the constraints on what a photon is as they are imposed by one of its sources, the transition of an atomic orbital electron from an outer to an inner orbit which transition must fit and match to, the following requirements.

- The transition is a change from the initial state to the final state as in part of a single cycle of an oscillation. It is not a changing to a different state and then returning back to the original state as in a full cycle of an oscillation.
- To avoid an infinite rate of change, which is impossible, the transition must be a smooth variation, without any sudden "jump". The resulting radiation exhibits all of the characteristics of Maxwellian (E-M) wave and is at one simple frequency, the photon frequency. The photon must be in the form of a simple sinusoid.
- At least a sample every half-cycle of an oscillation is required to specify it sufficiently. The photon must be in the form of a half-cycle sinusoidal function of time.
- Magnetic field is proportional to the velocity of the moving electric charge producing that field. Therefore the magnetic field of the photon is directly proportional to the transitioning electron's velocity. Since the photon magnetic field must be a half-cycle sinusoid the transitioning electron's velocity variation must be of a half-cycle sinusoid form.
- The electron velocity must vary in accordance with the above from the stable velocity of the initial orbit through a period of increase and ending in the stable velocity of the final orbit. The combination of these factors results in the specification that the photon is a half cycle sinusoid variation behaving as in the following Figure 3-3.



3-3 – The Orbit Transitioning Photon Generating Electron Behavior

The electron, traveling from its initial outer orbit to its final inner orbit with its velocity gradually increasing in a sinusoidal manner as in Figure 3-3 follows a path as illustrated in Figure 3-4, below, and emits an (E-M) wave field in “doughnut form” as in Figure 3-5, below, relative to its instant-by-instant varying vector velocity direction at each instant of the transition.

The peculiar shape of that field because of the directional orientation of the “doughnut” swinging through a substantial portion of a full circle according to the path of the electron’s orbital descent causes the propagated (E-M) wave to contain the requisite form, angular momentum and energy for causing an encountered orbital electron elsewhere to be elevated to a higher orbit equivalent

to the higher orbit that the electron previously descended from. The propagated (E-M) burst contains and transmits both energy and angular momentum.

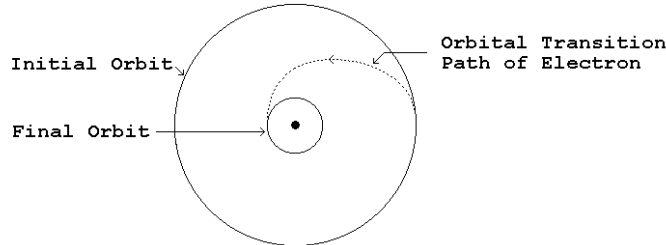


Figure 3-4 – Typical Electron Outer-to-Inner orbit Change Path

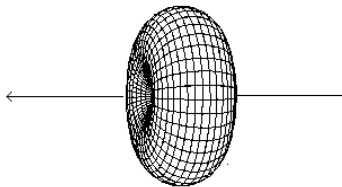


Figure 3-5 – Instantaneous Electro-Magnetic Radiation Pattern [doughnut shape] of a Single Electron Traveling Horizontally.

Calculation of Orbital Transitions

Knowing the time duration of the electron's orbital transition relative to the electron orbital period is helpful in visualizing the process. The orbital transition takes place in the time of one-half cycle of the photon's frequency. Letting “D xx” symbolize “the duration of xx” then

$$(3-2) \quad D \text{ orbital transition} = D \text{ photon} = \frac{1}{2 \cdot \text{photon frequency}}$$

Let n be the orbit number, an integer representing the number of matter wavelengths in the orbit. The electron orbital velocity is proportional to $1/n$. Its matter wave frequency is proportional to $1/n^2$. The photon frequency is equal to one-half the difference between the initial and final orbits matter wave frequencies. From those, the duration of the orbital transition in terms of the duration per orbit in the final orbit is

$$(3-3) \quad \frac{D \text{ orbital transition}}{D \text{ final orbit}} = \frac{n_{\text{initial}}^2}{n_{\text{final}} [n_{\text{initial}}^2 - n_{\text{final}}^2]}$$

n_i	n_f	Transition/ final orbit	n_i	n_f	Transition/ final orbit
2	1	4/3	4	3	16/21 ↓
3	1	9/8	5	3	25/48
3	2	9/10	6	3	36/81
4	2	4/6	7	3	49/120

Table 3-1 – Orbital Transitions

The transition takes place in $1^{1/3}$ final orbit periods at most [$n_i = 2, n_f = 1$], and in less than 1 final orbit period for most cases [$n_f > 1$]. The orbit transition and photon emission take place with the electron traveling a significant portion of an orbit around the atomic nucleus in all cases.

Looked at another way, the transitioning electron travels in the range of on the order of 180° to 360° of a circular orbit. Its path being curved its direction at instants during the transition changes by on the order of 180° to 360° . Such a path is completely incompatible with a particulate photon being emitted in some one specific direction by that transition.

It is clear from the above that for the radiation emitted in this circumstance, which radiation is the photon, it is impossible that it travel outward away in a single specific direction as required for the photon-particle hypothesis. Furthermore, there are other problems with that hypothesis.

Perhaps the greatest other problem with the photon-particle theory is as follows. The wavelength of light is in the range of 10^{-7} meters. Atomic dimensions are on the order of 10^{-10} meters so that if a photon is to contain wavelength data relevant to the light that it represents, it must then have dimensions that are on the order of $10^3 = 1000$ times the size of an entire atom let alone than the size of a much smaller electron. Clearly this is completely at variance with the photon-particle explanation of the photoelectric effect.

For example, in the Einstein photoelectric effect instance of a photon-particle causing the freeing of an electron from the material it is in there would be, relatively speaking, a *football size photon* interacting with a *sand grain size atom*, the football-photon managing to focus its action solely on one *germ size electron* in the *sand grain size atom* without disturbing any of the rest of the atom.

Clearly, by the analysis of cause, the theory of the particle photon is untenable. What remains is the photon wave.

RESOLUTION OF THE PHOTON'S SEEMING PARTICLE-LIKE BEHAVIOR

The description of the earlier above photoelectric photon scenario, there illustrated in terms of relative metaphorical particles [*football photon, sand grain atom, germ size electron*], however now treated as the interaction of (E-M) wave radiation and the atomic orbital electron, is as follows.

For the hypothetical photon all of its energy, $W = h \cdot f$ resides concentrated in the lone particle at its momentary location. But, for the actual case not of a lone particle but of an (E-M) field, a wave burst of a half cycle sinusoid spread out in space, the energy $W = h \cdot f$ resides in its outward propagating ever-expanding wave front where its local values at points along that wave front are progressively inverse square reduced.

There are only two alternative ways that that spread out energy can act like the concentrated energy in the theoretical photon:

[a] – When the wave is focused into a collimated beam [literally forcing the concentration of its $W = h \cdot f$] [that is the effective action of a laser and the means in a photoelectric “eye” used to detect interruption of the light as a signal that some action must be taken],

[b] – When the wave fronts of a number of independent wave bursts of radiation coincide at a point of action and consequently add up and amount to the requisite energy. With the plethora of wave bursts available such coinciding is common for example the piece of iron on page 20.

The data of Figure 3-2 requires using a collimated beam of light of a controlled single frequency.

The photoelectric process is not unlike that in an antenna’s reception of a radio signal in which the part of the arriving passing (E-M) wave that actually encounters free electrons in the antenna material induces motion in those free electrons, motion corresponding to that which generated the original causing radio waves. Of the total of all wave bursts encountering an atom, only those that directly encounter a particular orbital electron affect that electron’s motion. Most of the time that effect is not to elevate the electron to a higher stable orbit. Rather, the effect is to elevate the electron to a higher energy level where it is in an unstable position and it immediately re-radiates the (E-M) wave that acted on it and returns to its lower stable orbit. To an external observer it is as if nothing happened.

But, a correctly coordinated subset of incoming wave bursts coinciding will elevate an encountered electron high enough to be free as a photoelectron. (E-M) burst subsets of sufficient energy elevate electrons to an electric current free of the metal atom on which the incoming (E-M) wave was incident. That “incoming photon” is actually a coordinated subset of the plethora of half-cycle (E-M) wave bursts.

Einstein’s description of the photoelectric effect is valid except for his invention of the photon for which the (E-M) half cycle wave bursts perform the same function, a function that Einstein’s photons cannot perform. His neglect of the necessity of cause led to his photon mistake.

Thus:

Einstein’s photoelectric effect is not a special quantum effect, it is only classical particles operating classically.

But, why is the energy in an (E-M) wave burst, the quantized energy of black body radiation, dependent only on the wave burst’s frequency as in

$W = h \cdot f$? The amount of energy naturally depends on frequency. The higher the frequency the more rapidly the (E-M) radiation oscillates. The (E-M) radiation carries the ability to cause corresponding change in motion in encountered charged particles. It requires more energy per time to make a rapid change than to make a gradual one. A shorter period (higher frequency) half-cycle sinusoid must contain directly proportional greater energy to produce the proportionally more rapid change.

But, there is a role for the photon while not in nature nevertheless in the laboratory as follows.

Special Cases - Laboratory Photons

The discussion and treatment of photons to this point has been of only natural world photons behaving in their natural fashion without any interference or action by humans. As to be expected the situation is somewhat modified when dealing with the effects of humans; however, there is no change in the fundamentals that photons are a purely (E-M) field effect not that of a discrete particle.

Radiating photons as above, whose (E-M) field disperses widely in nature, are focused, collimated into a monodirectional beam in the laboratory. That beam, in its effect upon encountering matter, is effectively a stream of photon particles, each still a half cycle burst of (E-M) field but having a particle's one specific direction.

Lasers are another example of the use of single frequency focused beams of the half cycle sinusoidal bursts of (E-M) waves that would otherwise widely disperse. In the case of the laser the result is an optical "current" of those bursts, which in its single frequency and (E-M) oscillation is essentially equivalent to the electrically generated carrier waves which carry radio and broadcast transmitted information in modulation applied to the carrier.

In general all experiments on the nature and behavior of light depend on using artificial light, that is single frequency light that is focused or collimated into a narrow monodirectional beam, which gives it some of the appearances of a particle while still retaining its (E-M) nature. Thus, in a sense, the problem of the wave-particle duality of light is the issue of "which light" – light as in free nature or specialized laboratory light.

*STEP 3 – STABLE ELECTRON ORBITS AND ATOMIC LINE
SPECTRA*

Step 1 showed that the cause of the quantization that appeared in the solution to the problem in the radiation of black body heat is not a subtle underpinning of Quantum Mechanics. Rather, it is an aspect of normal classical physics, the normal behavior of classical Maxwell's equations' electromagnetic (E-M) radiation in the circumstance of the individual atoms of a material black body..

Step 2 showed by analysis of cause that the photon and its entire particle conception does not exist [except in man-made artificially focused light] and that the quantization that Einstein theorized in his explanation of the photoelectric effect is not a subtle underpinning of Quantum Mechanics. Rather, it is an aspect of normal classical physics, the normal behavior of classical Maxwell's equations' electromagnetic (E-M) radiation.

Now Step 3 confronts the appearance of quantization in the phenomenon of the discrete stable orbits of atom's orbiting electrons.

Rutherford's experiments, passing alpha particles through metal foil, show that atoms consist of a quite small nucleus, which contains all of the positive charge of the atom and almost all of its mass, with the large remainder of the volume of the atom being empty space in which the electrons are found. The only way for the negatively charged electrons to exist in such a context without being drawn into the positive nucleus by the Coulomb attraction is for each electron to move around the nucleus in an orbit such that the Coulomb attraction toward the nucleus is just correct to curve the electron into its orbital path (the "centrifugal force" offsets the Coulomb attraction). Thus arises the "planetary" model of the atom.

In this model as so far presented, the electrons could be in any of continuum of orbits from close in to the nucleus to far out from it, the orbit speed being for any orbit the correct amount to balance the Coulomb attraction at that radial distance from the nucleus. But such electrons are continuously accelerated into their curved paths and classical physics expects that a n accelerated electron should emit (E-M) radiation. Since emitted radiation

carries energy the orbital electrons should lose energy to the radiation and be unable maintain the required orbital speed. Thus the electrons should be expected to emit (E-M) radiation and fall toward the nucleus rather than remaining in orbital stability.

That classically expected radiation does not in general occur in atoms, however (and if it did occur atoms could not exist). Atomic orbital electrons do sometimes give off some radiation; however, it is not a continuum over a range of frequencies as would be expected classically if the electrons were to radiate continuously, lose energy and spiral inward toward the nucleus. Rather, under suitable conditions, atoms emit a small number of specific discrete frequencies of (E-M) radiation [atomic line spectra]. The spectrum of a particular elements' atoms always contains the same specific set of frequencies and only those.

The hypothesis for this behavior, and for the orbital structure of the atom is due to the physicist Bohr. It is that the electrons can exist in a stable state without radiating only in certain discrete orbits, all other orbits being unstable so that electrons in them lose energy and fall out of orbit because of radiating as expected. No reason is given for the stable orbits being stable, it is simply accepted as apparent fact.

Bohr postulated that the stable orbits are such that the angular momentum of the orbital electron is an integral multiple of Planck's constant divided by 2π , equation (3-7)

$$(3-7) \quad \text{Angular Momentum} = \text{Integer Multiple of } h/2\pi$$

$$m \cdot v \cdot r = \frac{n \cdot h}{2\pi} \quad [n = 1, 2, \dots]$$

No cause for the relationship between orbital angular momentum and stability of the electron's orbit was proffered nor has it yet been proffered. It remains simply accepted as fact because it "works".

The solution to this problem requires treatment of matter waves. Matter waves have been largely ignored by modern physics because, while the matter wave wavelength has been experimentally demonstrated no satisfactory formulation for the matter wave frequency had been found. That problem is resolved in Appendix D where it is also shown that the matter wave wavelength is

$$(3-8) \quad \lambda_{mw} = \frac{h}{m \cdot v}$$

Using that result, the angular momentum formulation of equation (3-7) is actually a mis-arrangement of the requirement that the electron's circular orbit

path length $2 \cdot \pi \cdot r$ must contain exactly an integral number of matter wave wavelengths as follows by merely re-arranging equation (3-7) as equation (3-8).

(3-8) Orbit Circumference = Matter Wavelength Integer Multiple

$$2 \cdot \pi \cdot r = \frac{n \cdot h}{m \cdot v} = n \cdot \lambda_{mw} \quad [n = 1, 2, \dots]$$

Unlike the case of the orbital angular momentum explanation of the stable orbits, for which an explanation is not proffered, there is sound cause for the stable orbits depending on the orbiting electrons' matter wavelength as follows.

For the orbit to be stable it must be the same for each pass, pass after pass. If each pass includes exactly an integer number of the orbital electron's matter wave lengths then each pass is the same in that regard. But if, for example, the orbital path length contains only $9/10$ of a matter wave length, $9/10$ of the matter wave period, then the next pass will contain the missing $1/10$ of the matter wave length or wave period plus $8/10$ of the next, and so on. The matter wave being sinusoidal in form, the successive orbital passes will be all different.

It is this behavior which operatively causes the "stable orbits", and only those orbits, to be stable. It has nothing to do with angular momentum nor quantization of angular momentum. For the angular momentum hypothesis there is no underlying reason nor mechanism to produce stability or instability. The quantization of angular momentum concept is merely a defined condition, without operative cause, just as were the "stable orbits" it seeks to explain until their here being justified in terms of the operative matter wave behavior.

This behavior is not a special quantum effect; it is only classical particles operating classically.

RELATION TO THE PROBLEMS OF QUANTUM MECHANICS

The above "quantization" experiments and their analyses [now corrected in the preceding [Step 1, 2, and 3](#)] in their originally understood behavior before correction, essentially led directly to the beginning of Quantum Mechanics. Those behaviors that gave rise to Quantum Mechanics theory have now all been shown to be

*behavior that is not a special quantum effect,
but is only classical particles operating classically.*

However, thus started, the field of Quantum Mechanics developed several fundamental concepts principally as follows.

Principle #1

- That particles exist only in a superposition of all of their possible states as determined by the particle's "wave function", a mathematical description of the quantum state of an isolated quantum system from which the probabilities for the possible results of measurements made on the system can be derived.

Principle #2

- That particles only so exist until their being "observed or measured" causes selection of a specific one of that multitude of states, an event termed "collapse" of the wave function.

Principle #3

- That particles can be entangled, a quantum mechanical phenomenon in which the states of two or more particles can only be described with reference to each other even though the individual objects may be spatially separated.

Quantum Mechanics offers no causality, no mechanism for any of these contended principles.

They are unsupported unjustified assumptions.

This is addressed in the following Step 4.

STEP 4 – CAUSALITY, LOCAL REALISM AND ENTANGLEMENT

THE PROBLEM - 1

Locality states that an object is only directly influenced by its immediate surroundings. For an action at one location to have an influence at another non-contiguous location, something in the space between the locations must mediate the spatial separation.

Quantum Mechanics claims Entanglement a joint state of two or more particles where one particle instantly "knows" what happens to and what is the state of the other and appears to be able to force a change in the state of the other, even though there appears to be no means for such communication between the particles, which may be separated by arbitrarily large distances.

Clearly the two are opposed. One claims that the spatially separate have no interaction unless something intervenes to mediate the separation. The other claims that the spatially separate can significantly interact without any intervening mediation. Either one or the other might be valid but both cannot be simultaneously valid. Which is it?

THE PROBLEM - 2

Local Realism states that an object exists independently of knowledge, thought, or understanding of it. It is the principle that all objects objectively have a pre-existing value of any of their measureable characteristics independent of any measurement that is made and before the measurement is made. Measurement cannot and does not create or initiate the value.

Quantum Mechanics claims the opposite, that objects are in the form of a superposition of all of their possible states, as described by a probabilistic wave function, and lack specific existence until a measurement or observation causes the selection of one out of the set of possible states, that one being "the object".

Clearly the two are opposed. One claims that an object has complete existence independent of any measurement or observation. The other claims that an object's existence becomes fulfilled only by a measurement or observation of the object acting upon its set of superposed states to select one. Either one or the other might be valid but both cannot be simultaneously valid. Which is it?

Quantum Mechanics cites the EPR Paradox type experiments as proof of its Entanglement and violation of Locality.

The EPR Paradox.

The EPR Paradox (or Experiment) is so named because it was a thought experiment devised by Einstein, Boris Podolsky and Nathan Rosen in 1934-1935. In 1976 and subsequently the experiment has been physically run. The results have always been interpreted as favoring 'non-locality', the opposite of classical 'locality'.

In the experiment a pair of protons, for example, entangled, associated with one another in a singlet state will always have a total angular momentum of zero, as they each have equal and opposite amounts of spin.

According to Quantum Mechanics, for each of the protons its probability wave will not collapse and its specific spin be decided until it has been measured (observed). If one measures the spin of one proton, according to quantum theory, the other proton instantly "knows" and adopts the opposite spin its probability wave having simultaneously likewise collapsed.

Separating the particles in opposite directions and measuring one of them for spin has been carried out over a distance of 10 km. The instant it is measured and the spin determined, the other particle apparently adopts the opposite spin. The time interval is zero, instantaneous.

It would appear that something is communicating between the particles and at light speed or faster. But, what and how ? We must identify and understand the mechanism producing the observed quantum entanglement effects or else find and demonstrate that the effects are not real and only apparent. Otherwise, failing those two, the observed quantum entanglement effects are real as observed and interpreted but have no cause, no mechanism and, therefore, are, by definition, *supernatural magic* which is scientifically unacceptable.

The resolution of the above two conflicts, The Problem-1 and The Problem-2, are treated in the following sub sections "On Locality" and "On Local Realism". First to be addressed is Locality

ON LOCALITY

ANALYSIS OF ENTANGLED QUANTUM EFFECTS COMMUNICATION

Entanglement is defined by the following: If two particles are in a state such that there is a matching correlation between two canonically conjugate dynamical quantities, they are termed as being "entangled". Such entangled behavior has been noted in instances, for example, of particle angular momentum and of photon polarization.

The correlation means that there is “coherence” among the entangled particles. When the coherence is lost the particles are “decohered”.

According to Quantum Mechanics any measurement of a property of a particle causes an irreversible collapse of its wave function to the just measured quantum state of the particle. In the case of entangled particles, the effect of such a measurement will be on the entangled system as a whole.

Requirements for Entanglement Mechanism

For the entangled “matching” to be maintained there must be a communication among the entangled particles, there must be something flowing from each to all of the others so that each has the necessary information to determine what its specific matched correlated state must be.

Because the entangled particles are continuously in motion, curvilinear or oscillatory about a location, directing the communicating flow from particle to particle is impractical because the location to which to send the outgoing communication is indeterminate. Therefore, it cannot be directed to solely those of the entanglement. The only alternative is that the communication must be generally broadcast.

Because any particle might be called on to participate in an entanglement, every particle, all particles, must be continuously broadcasting their quantum state so that a means is required to leave non-entangled particles unaffected by the operating of the entanglement matching action..

In order for the communicated enforcement to affect only the entangled particles, when two or more particles are entangled there must be some kind of entanglement identification mark or notation placed on each entangled particle, the mark identifying each as part of a system of entangled particles and in that role in its part in the “matching correlation between the conjugate dynamical quantities” of its entanglement being maintained.

Lacking that identifying mark a particle is not involved in a “matching correlation” and is not entangled.

Furthermore there must be something enforcing the maintenance of the correlation at each entangled particle. For example in the case of entangled particles “A” and “B”, upon a change in the state of “A” a communication must be sent to “B” and: either [a] that communication itself from “A” received at “B” has a mechanism to cause or force “B” to change its state to the new correlation, or [b] the entangled “B” itself has such a mechanism to cause or force itself to change its state to the new correlation, that “B” mechanism being triggered into action by the received communication from “A”.

Either that mechanism is inherent in every particle or else it must be placed into each particle upon initiation of the entanglement and removed upon each decoherence.

In summary entanglement involves the following requirements:

- 1 - Every particle must be broadcasting information as to its current quantum state;
- 2 - Each entangled particle must have an identification to that effect;
- 3 - For each entangled pair there must be mechanism that enforces “matching correlation”.

There is, in fact, a communicating flow from every particle to every other particle in the universe. That flow, developed in the earlier Section 2 and Appendix A2 is described as follows.

Requirement #1-The Flow from Particle Centers-of-Oscillation

In Section 2 and Appendix A2 it is found that there is a spherically outward flow of oscillatory *Medium* wave from every particle. That existing flow is the only possible candidate for the communicating flow to be the mechanism for entanglement because that flow already exists. [That *Propagated Outward Flow* has a primary role in gravitation and in the action of Coulomb’s Law and Ampere’s Law. A second universally broadcast such flow in addition is not possible because it would interfere with the existing *Propagated Outward Flow*.]

That Which is Flowing

- Contemporary particles are Big Bang successors of the original [1 - *Cosine*] oscillations with which the universe began. Thus the outward flow of the original oscillations is a property of present particles. That which is flowing is the same original primal *Medium*, the substance of the original oscillations, as at the beginning of the universe.

- Since it is flowing outward from each of the myriad particles of the universe simultaneously and since that flow is interacting with the myriad other flows of those particles without untoward interference, the *Medium* must be extremely intangible for all of that to take place. Any one particle's flow flowing largely freely through that of other particles, is as intangible as ... well , "field".

The Oscillatory Medium Flow

- The initial medium supply of the universe, oscillating in [1 - *Cosine*] form, came into existence at the Big Bang. Therefore the initial medium supply of each particle, each being a direct "descendant" of the original oscillation at the universe's beginning, must be likewise oscillatory in form. Therefore the radially outward flow from each particle is likewise an oscillatory medium flow of the same [1 - *Cosine*] form.

- For such a flow to persist there must be a supply of that outward flowing substance in every particle. And, for that flow to have persisted the billions of years since the “Big Bang” that “supply” must be an extremely concentrated reservoir of that which flows outward [concentrated relative to the outward flow].

- That reservoir is the spherical “core” of radius $d = \sqrt{2\pi} \cdot \lambda_p$, per equation (2-9), at the center of all particles.

The source of the flow is particles, which are generally always in motion. For particles in motion the propagated flow is forced by the combination of the particle’s velocity and the velocity of propagation to be different in the forward, and rearward directions. Those differences overall carry information about the state of the particle including its direction, velocity, energy, frequency and mass.

But particles encountering that flow experience only a very small portion of the total spherical wave front propagated by the particles, a sample that may be of its forward only, or sideward only, or whatever part of the total picture.

Nevertheless, for “canonically conjugate dynamical quantities”, that is those involved in the entangled state, quantities such as angular momentum or polarization, the broadcast flow, regardless of the motion of its source particle, is sufficient to carry the information as to state.

Thus the actual communicating flow can satisfy the quantum requirement #1 namely broadcast communication

Requirements #2 & #3

There remains the requirements #2 and #3, entanglement identification and means to enforce the correlation of quantum states for neither of which is there resource in the existing, already treated above, flow.

Any secondary additional universal flow would, by the presence of its own “core” interfere with the onmi-directional role of the earlier original “core”.

Consequently, there is no facility naturally in the particles to be entangled to perform the communication requirements #2 [entanglement identification] and #3 [correlation enforcement] other than a facility introduced in the act of initiating the entanglement.

But, there are limitations on what can be added to or imposed on the pre-entanglement particles or photons about to be entangled and those limitations eliminate meeting the communication requirements #2 and 3. Those limitations are:

For particles:

-They must not change the average amplitude nor the average frequency of the particle because those would change its electrostatic or gravitational action.

-It is difficult to conceive of the insertion into each of the component particles of an entanglement what would be, in effect a piece of software that: detects the entanglement, evaluates and compares the states of the participants in the entanglement, and causes adjustment of state to that required by the entanglement.

For photons:

-While particles are a continuously propagated wave front having a source core, photons are merely half cycle oscillatory bursts of wave front propagating from a momentary transient effect [e.g. an atomic electron orbit change]. The addition or insertion of anything like the proposed software for the particles case into a photon is very problematic.

Conclusion of Analysis of Quantum Effects Communication

Having now found that there is no mechanism able to support or justify the Quantum Mechanics interpretation of entanglement effects;

that is, having shown that the entanglement and anti-locality

Principle #1 of Quantum Mechanics [page 34] is unjustified

assumption and not causality supported,

it remains to investigate whether those effects are real or only apparent because science cannot accept their being real but lacking cause and mechanism, which is the definition of *supernatural magic*.

ON LOCAL REALISM

ANALYSIS THAT THE ENTANGLED QUANTUM EFFECTS ARE NOT REAL

In terms of Quantum Mechanics, for example in the EPR paradox, before the measurement and consequent “collapse” where are the protons’ angular momentums [spin angular momenta] located, or how are they expressed ? The only place available is in each proton’s wave function because that is the only thing specifically related to each proton. Quantum Mechanics contends that the two protons don’t specifically “exist” until their probability waves collapse. But, the wave function is non-material and cannot contain angular momentum, only probability. If the two particles’ angular momentums do not exist somewhere before the measurement and its “collapse” they cannot exist afterward. The “collapse” cannot call them into existence from nothing.

Quantum Mechanics would argue that before the “collapse” the protons do exist “in a superposition of all possible states for them”. But then, where is their angular momentum ?

- Is it in full in each of those superposed states ready for any one of them to be selected at the “collapse” ? Then how did only one protons worth

of angular momentum get so enlarged ? And what of the left over angular momenta in the multitude of states not selected at the “collapse”?

- Is it spread out allocated among the various possible superposed states ? How can that happen ? By what mechanism ? And how is it all collected, reunited into the specific state selected at the collapse ?
- Is it only in the state to which the superposition collapses ? But which state that is is not determined until the instant of collapse ...
- ... and, if that state were earlier determined what point would there then be to the variety of other states in the superposition, states then with no function nor possibility of reality ?
- Is there anywhere it exists prior to the collapse ? If so then its particle exists prior to the collapse.

Therefore the two protons must, and do, “pre-exist” with opposite spins in correlation as if already “collapsed” before the first measurement. Thus there is no probability wave to “collapse” because the state that results from collapse is already extant.

Furthermore, the same three points of criticism applied just above to angular momentum can be repeated with each of the properties of a particle, for example its mass and its electric charge.

- Are they in full in each superposed state ?
[does one proton’s worth expand]
- or Are they spread out allocated among those states ?
[by what mechanics]
- or Are they only in the state that survives the collapse ?
[not known in advance]
[and rendering the unselected states as pointless]
- Is there anywhere they exist prior to the collapse ? If so then their particle exists prior to the collapse.

This shows that the Quantum Mechanics rejection of Local Realism is not valid and,

*it has been shown that the superposition of states and anti-reality,
Principles #2 & #3 of Quantum Mechanics [page 33-34] are
unjustified assumptions and not causality supported,*

Particles exist independent of whether observed or not, and there is no “collapse of the wave function” to bring particles’ supposed multiple superposed states into existence. as “the particle”.

The problem of instantaneous communication goes away with the protons in “existence” and spinning oppositely in their correlated spins before the first measurement. Then measuring one and finding the other instantaneously correlated is assured because it was “pre-assured”.

There is no question nor issue of “action at a distance” at all here because there is no actual “action”. Being a contended example of entanglement, the EPR experiment actually supports Locality and denies Entanglement. The above critical analysis applies as presented for protons, electrons, photons and all such atomic scale particles. [In the case of photons the entangled property is angle of polarization].

SUMMARY OF ANALYSIS

It was found above that there is no mechanism able to support or justify the Quantum Mechanics claim of successful violation of Locality and its interpretation of entanglement effects.

The conclusion of the problem of the EPR experiment has found that Local Realism is valid, particles do exist independently of whether observed or not, and there is no “collapse of the wave function” to bring particles into existence. That means that the wave function is only a mathematical invention and does not exist in material reality.

In the EPR experiment before any first particle measurement the entangled particles all “existed” and were each in its proper state correlated with the others. They were material particles not “wave functions”. They did not need “collapse” to come into material existence and they would experience no “collapse” because there was no probability wave there to collapse. They all are in a set of correlated states after the measurements as before.

Consequently their separation distances were of no concern and there was no “spooky” action, no violation of Locality.

Re Hidden Variables

Hidden variable theories are proposals to provide explanations of quantum mechanical phenomena. Most hidden variable theories are attempts to create a determined description of quantum mechanics. Bell's theorem would suggest that some hidden variables that attempt to find a complete description of reality, which is incomplete in Quantum Mechanics, are impossible. That is also demonstrated in the prior Section 3.

But, nothing in the present “On the Necessity of Causation” is hidden; nothing in the analyses is hidden. Rather it is all specifically and exactly demonstrated by causal analysis of the classical physics involved and contains no “hidden variables”.

Rather than seeking hidden variables, the analysis of Quantum Mechanics here presented also shows that hidden variables are impossible.

*SUMMARY – CAUSALITY, LOCAL REALISM AND QUANTUM
MECHANICS*

The entire field of *Quantum Mechanics* followed from applying the following:

- The principle of quantization, the concept that Planck first introduced to obtain a theoretical black body radiation curve that matches experimental reality,
 - the quantization of photons in Einstein's photoelectric effect, and
 - The quantized stable orbits developed by Bohr.
- The simple direct mechanism operative in the case of each of these has been developed and demonstrates the absence of any quantum quantization operative in the effects.

Each of those has now been shown to be defective in their attempted effort to attribute new physics' of quantization to normal classical physics behavior. Each is here now resolved by the presented cause-based analyses and mechanisms for black body radiation, the photoelectric effect and the photon, and the line spectra of gases as related to the electron orbital model of the atom.

- And now, the Quantum Mechanic's denial of Local Realism and Locality has been, is, put to rest by the analysis of the applicable causality and the principles of Local Realism and Locality continue to dominate physics as they always have.

Quantum Mechanics, as the development of the extensions of quantization and the wave aspect of matter to the theoretical description and analysis of all or most atomic behavior, suffers from its lack of attention to causality and its neglect of its essential component, mechanism as also so suffer its attempted destruction of Local Realism and Locality.

And, The Necessity of Cause is further demonstrated.

