Quantum Wave-function Collapse Discovered Inside-Out

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Abstract

We present a beam-split coincidence test of the photon model, previously done with visible light, now performed for the first time with gamma-rays. A similar new test is presented using alpha-rays. In both tests, coincidence rates greatly exceed chance, revealing the flaw of quantum mechanics (QM). A newly formulated threshold model predicted this flaw of QM. We use our threshold model to derive equations for effects thought to require conventional quantization. Conventional quantization denies sub-quantum states that are allowed by the threshold model. Our threshold model embraces Planck's second theory of 1911, where he used h as a maximum. We extended Planck's theory by similarly treating e and m so that all three constants of the electron (h, e, m, for *action, charge, mass* respectively) are realized as maximum threshold-constants. We then use ratios of those constants, like $e/m = Q_{e/m}$, for the spreading wave. By quantizing the Q's and thresholding h, e, and m, a matter-wave can spread and load to a threshold upon absorption. Therefore, wave-function collapse is avoided. The quantum disconuity is still present. However our two-for-one effect in our experiments identify a pre-loaded state. Such a pre-loaded state reveals that a loading to a threshold is at play instead of a spooky wave-function collapse. We also identify several false assumptions that made any alternative to QM doomed to fail in experiments designed to reveal the distinction. The difficulty of realizing an experimental distinction between an inside-out threshold and quantization is why quantum mechanics maintained such a strong illusion. ER 5, 21, 2021.

Keywords: Quantum mechanics, Wave-particle duality, Entanglement, Measurement problem, Wave-function collapse, Photons, Gamma-rays, Alpha-rays, Born rule, Complementarity, de Broglie wave, Photoelectric effect, Unquantum.

Introduction

The measurement problem, wave-particle duality, entanglement, non-locality, collapse of the wave function, spooky action at a distance, Schroedinger's cat, Born rule, and weirdness relating to quantum mechanics (QM) are all the same thing. Quantum mechanics has endured despite its bizarre implications because no strong experimental evidence has been recognized to refute it. My evidence has been public since 2003. This evidence includes experiments with gamma and alpha-rays, a workable hypothesis, and critique of past experiments.

The language of particles and waves is hopelessly confusing because the words have different meanings depending on their QM or classical context. A classical particle holds itself together and can be anything from a dimensionless point to a galaxy. A wave does not hold itself together and spreads. Classical wave and classical particle models are mutually exclusive. For the meaning of a QM particle, the photon, I quote the experts. Here N Bohr paraphrases Einstein:

> "If a semi-reflecting mirror is placed in the way of a photon, leaving two possibilities for its direction of propagation, the photon would be recorded on one, and only one, of the two photographic plates situated at great distances in the two directions in question, or else we may, by replacing the plates by mirrors, observe these effects exhibiting an interference between the two reflected wave-trains [1]."

This is the particle-probability model of QM. It forces together classical wave and classical particle ideas. QM particles with zero rest mass, such as photons, and those with non-zero rest mass are treated the same way. Therefore, to make any sense of what a modern physicist means when they talk of a QM particle, you must accept an incomprehensible model, not a thing. Slang for this conundrum is "shut up and calculate." One might try to change the definition of the photon to mean a detector click. However, that would be too confusing. I recommend we talk only of the detection threshold energy $h\nu$, pronounced *h-new.*

The leading part of Einstein's definition has been tested many times of past and as described here; it is called a beam-split coincidence test. By QM and the photon model, a singly emitted energy $h\nu_L$ must not trigger two coincident $h\nu_L$ detection clicks in a beam-split coincidence test [1, 2]. Here h = Planck's constant of action, and ν_L = Light frequency. Beam-split coincidence tests of past have seemingly confirmed QM by measuring coincidence rates at only the rate due to accidental chance [3-6].

The innovation here is to perform the beam-split coincidence test with gamma-rays (γ) instead of visible light. We will show that our experimental results are consistent with the long-abandoned accumulation hypothesis, also called the loading theory [7-14]. The loading hypothesis of past was on the right track but it was not understood how it could work. We repaired that hypothesis, and now call it the Threshold Model (TM). For light, TM implies that a fraction of detectable energy was pre-loaded in the detector atoms, preceding the event of an incoming classical pulse of radiant energy.

There is a subtle distinction between quantization and thresholding. Thresholding allows for a pre-loaded state that is not easily recognized. Quantization denies the existence of such a pre-loaded state. In most experiments, thresholding will appear identical to quantization. This is how quantization is an illusion.

This pre-loaded energy must come from previous absorption, electromagnetic or otherwise, that did not yet fill-up to a threshold of energy $h\nu$. Energy conservation is usually assumed in terms of particles. Here we test this distinction: is energy conserved in a quantized sense, or in a more general sense? These tests confront us with a choice: we must either give up a quantum mechanical *particle-energy* conservation or give up energy conservation altogether. We uphold energy conservation. These new experiments tell us energy is thresholded in matter, and not generally quantized.

A beam-split coincidence test compares an expected chance coincidence rate R_c to a measured experimental coincidence rate R_e. Prior tests [3, 6] all gave $R_e/R_c = 1$ = chance. Past authors have admitted that exceeding chance would contradict QM. Our tests are the only tests to reveal $R_e/R_c > 1$. When this ratio exceeds unity we call it an unquantum effect. This clearly contradicts the one-to-one "Born rule" probability prediction of QM.

The threshold model takes h as a <u>maximum</u> of action. This idea of action allowed below h is "Planck's second theory" of 1911 [8, 9, 13, 14]. There, and in Planck's subsequent works, Planck took action as a property of matter, not light [9]. Planck understood light could be quantized at energy $h\nu_L$ <u>only</u> at the instant of emission, and thereafter light spreads classically. We agree.

Similarly, our new beam-split coincidence tests with alpha-rays (α) contradict QM by showing $R_e/R_c > 1$. This is important because both matter and light display wave-particle duality. Transcending the illusion of wave-function collase requires experiment and theory for both matter and light.

Gamma-ray beam-split tests

In a test of unambiguous distinction between QM and TM, the detection mechanism must adequately handle both time and energy in a beam-split coincidence test with two detectors, as we show in the following analysis. Surprisingly, our literature of quantum-oriented tests seems oblivious to the issue of detector pulse-heights. Specifically, this issue is ignored in accounts of all past 'single-particle' beam-split coincidence tests [3-6]. Those tests were all performed with visible light, except for one that was poorly performed using x-rays [3]. Referring to **figure 1** we will analyze a photomultiplier tube (PMT) pulse-height response to monochromatic visible light [15]. A single channel analyzer (SCA) is a filter instrument that outputs a square pulse (click) in response to a window of pulse-heights ΔE_{window}. LL is lower level and UL is upper level of this window. If we set LL to less than ½ E_{peak}, one could argue we favored TM because noise pulses or a down-conversion might take place to increase coincidence-counts. Alternatively, if we set LL higher than ½ E_{peak}, we would be unfair to TM by eliminating pulses that would generate coincidences by the unquantum effect. However, we need to set LL higher than ½ E_{peak} to test our prediction to exceed QM particle-energy conservation. Therefore a fair test pitting QM against TM requires pulse-height resolution with $E_{\text{peak}} >> \Delta E_{\text{window}}$. This criterion is not achieved with any PMT or avalanch photodiode, or any visible light detector even with cooling, but is easily met with γ-rays and

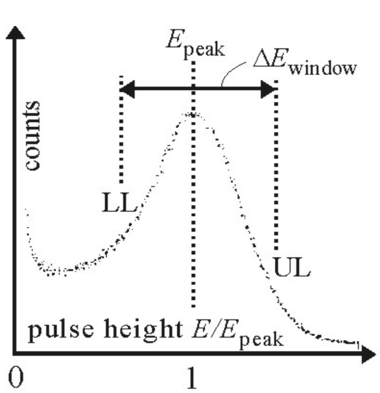

Figure 1. PMT pulse-height response

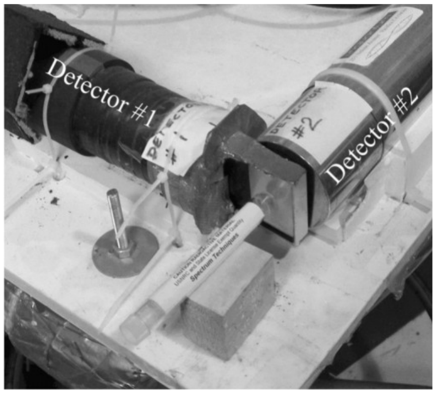

Figure 2. Two γ-ray detectors in tandem geometry. For the test described in the text, these detectors were placed in a lead shield.

scintillation detectors. Physicists have been oblivious to the importance of pulse-height resolution in these tests.

A high photoelectric effect detector-efficiency for the chosen γ-ray frequency was found to enhance the unquantum effect. The single 88 keV γ-ray emitted in spontaneous decay from cadmium-109, and detected with NaI scintillators fits this criterion [16] and worked well. There are only a few radioisotopes that emit only one γ at a time, have a reasonable half-life, and have high photoelectric efficiency. This is one reason why the quantum illusion was not previously uncovered.

Tests by others have shown that a detector with good pulse-height resolution will have its pulse-height proportional to electromagnetic frequency. Pulse-height and electromagnetic frequency for gamma-rays are always quantified in terms of electron volt energy units. Here, we only use eV for convenience. Of course, for a classical light beam, the flux in an area per time will also be an energy. Descriptions of radiant energy are confusing this way. After spontaneous decay by electron capture, ^{109}Cd becomes stable ^{109}Ag. ^{109}Cd also emits an x-ray below our LL setting.

We know that only one γ is emitted at a time from a true-coincidence test whereby the γ source is sandwiched between two facing detectors [17]. Even though the properties of these radioisotopes are well known, we performed the true-coincidence test in-house to be sure there was no contamination. Indeed, we did find some professionally sourced isotopes to be contaminated. In any beam-split coincidence test, chance is indicated by a flat band of noise on a Δt time-difference histogram. The chance

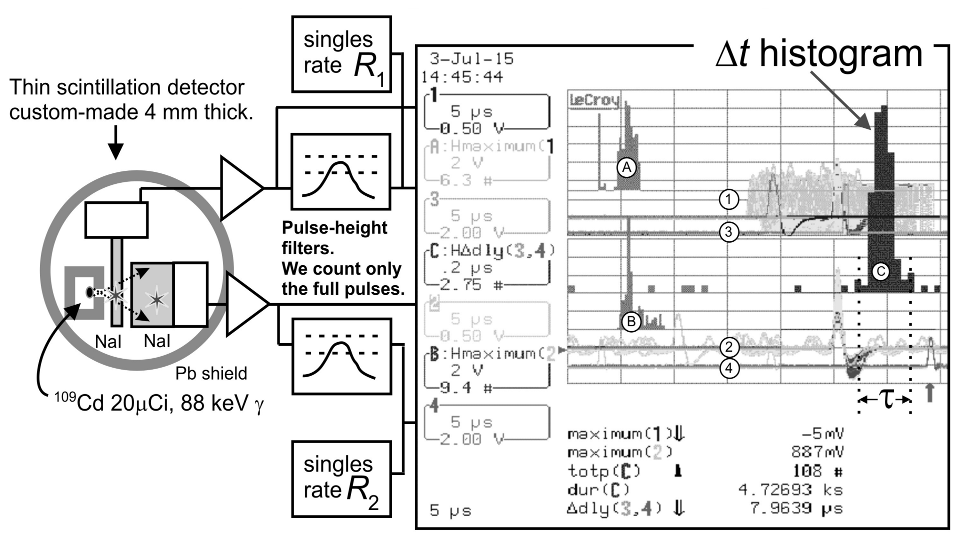

Figure 3. γ-ray experiment in tandem geometry using ^{109}Cd. DSO screen is annotated.

rate is measured and calculated by

$$R_c = R_1 R_2 \tau, \tag{1}$$

where R_1 and R_2 are the singles rates from each detector, and τ is the time window over which we are examining. In a true-coincidence test, if the experimental coincidence rate nearly equals this calculated chance rate, everyone agrees that the source emits one-at-a-time. The singles rate is the rate of pulses from a pulse-height filter, also called single-channel analyzer, SCA.

After performing this true-coincidence test we adjust the geometry of the detectors and keep the SCA settings. This geometry can either resemble a beam-splitter or what we call tandem. Tandem works best and is a thin detector in front of a thick detector (**figure 2**). The thin detector serves to tap away a fraction of γ energy, similar to what would happen in beam-split geometry. Each detector is a Sodium Iodide (NaI) scintillator crystal coupled to a PMT. γ–rays from ^{109}Cd are collimated by a lead box to optimize the path through both detectors. Lead, tungsten, and absent collimators were tested to determine that lead fluorescence was not a factor. The coincidence rate caused by background radiation must be subtracted.

Referring to **figure 3**, components for each of the two detector channels are an Ortec 471 amplifier, an Ortec 551 SCA, and an HP 5334 counter for singles rates. A four-channel LeCroy LT264 digital storage oscilloscope (DSO) with histogram software monitored the analog pulses from each amplifier on DSO channels (1) (2), SCA timing pulses (3) (4), pulse-height histograms (A) (B), and time difference Δt histogram (C) after each "qualified"-triggered sweep. The stored image of each triggered pulse showed well-behaved pulses to assure that noise and pulse-overlap were not confounding the test. Note our pulse-height resolution at (A) and (B). To assure exceeding *particle-energy* conservation, LL on each SCA window was set near 2/3 of the ^{109}Cd 88 keV γ characteristic pulse-height. That is, each pulse we pass in coincidence is easily greater than half of the average photopeak pulse. Each pulse is filtered to be within an energy window and each pulse-pair is filtered to be within a time window.

With no source present and a setting of τ = 500 ns, the coincidence background test had 304 counts/49.4 ks = 0.00615/s, a rate to be subtracted. With a source present and the same τ, the chance rate from Eq. 1 was R_c = (8.21/s)(269/s)(500 ns) = 0.0011/s. The experimental coincidence rate within that same τ was R_e = (108/4.73ks) – (0.00615/s) = 0.0167/s. The unquantum effect is taken as the ratio R_e/R_c = 0.0167/0.0011 = 15 times greater than chance. From similar tests, we found that such a robust effect was not some special case, but the effect has many variables.

Another similarly performed tandem geometry test used a two year old 25 μCi ^{57}Co check-source. ^{57}Co decays to stable ^{57}Fe. For this test we found the unquantum effect was enhanced by positioning the source three inches from the detectors. From this and other tests, a relationship between distance and frequency was discovered. The diameter of a spreading cone of γ matches the diameter of the atomic absorber, realized from a classical optics calculation.

With τ = 300 ns, R_e = 1874/16.9ks – 0.0139/s = 0.0970/s. R_c = (616/s)(82.9/s)(300ns) = 0.0153/s. R_e/R_c = 6.3. The unquantum effect works well with ^{109}Cd and ^{57}Co because their gamma's photoelectric effect efficiency exceeds Compton effect efficiency in NaI detectors.

The unquantum effect was first discovered in our lab in 2001. Many tests were performed [18, 19] to address: faulty instruments, contamination by ^{113}Cd in ^{109}Cd, lead fluorescence, cosmic rays, possibility of γ stimulated emission, pile-up errors, and PMT artifacts. Tests revealing an unquantum effect were performed with different sources (^{109}Cd, ^{57}Co, ^{241}Am, ^{22}Na [19]), different detectors (NaI, HPGe, bismuth germanate, CsI), different geometries, and different collimator materials. If γ can split in two, they can split in three, and this was observed in two different tests [18].

The unquantum effect is sensitive to temperature of the beam-splitter [21]. A liquid nitrogen cooled slab of aluminum delivered a 50% greater unquantum effect, in the direction we expected.

Magnetic effects were explored with coincidence gated pulse-height analysis [22] in beam-split geometry. A ferrite scatterer in a magnetic gap revealed enhanced Rayleigh scattering, indicating a stiff scatterer, as one would expect. A diamagnetic scatterer in a magnetic gap revealed enhanced Compton scattering, indicating a flexible scatterer, as expected.

Some have argued that I should arrange a trigger pulse in a triple coincidence test. This I did in 2007 with ^{22}Na [19]. Upon decay, this isotope emits a positron and a 1.27 MeV γ used in a trigger channel. The positron annihilates into two oppositely directed 511 keV γ, one of which was captured in a pair of bismuth germanate detectors in a triggered coincidence circuit. This test measured 29 times chance. Quantum mechanics would deny that any of this is possible.

By these experiments we interpret γ to be narrow-band electromagnetic shock waves. Here are a few conditions to watch for: The best detector is usually thought to be HPGe, but it turns out that NaI has a higher photoelectric efficiency. The unquantum effect is about the photoelectric effect. A high singles count-rate can drown out the effect. A low singles count rate can leave unquantum coincidence-counts buried in background-coincidences. The effect may be sensitive to source-detector distance, independent of count rate. It is best to optimize the fit of a collimated radiation cone to the detectors.

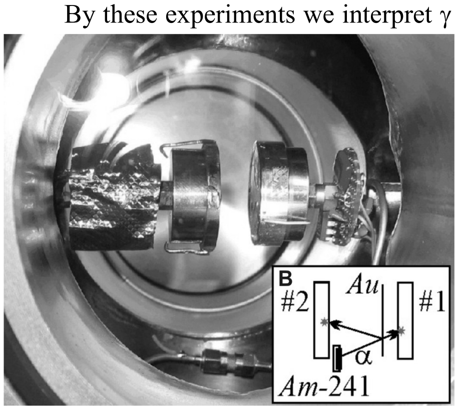

Figure 4. α-ray experiment.

Alpha-ray beam-split tests [23]

Americium-241 in spontaneous decay emits a single 5.5 MeV alpha-ray (α) and a 59.6 keV γ. An α is known as a helium nucleus. They call it the alpha particle, but consider a helium nuclear matter-wave. If the wave was probabilistic, the particle would go one way or another at a beam-splitter, and coincidence rates would approximate chance. We performed many and varied tests in four vacuum chamber rebuilds. One test is described here in detail.

Two silicon Ortec surface barrier detectors with adequate pulse-height resolution were employed in a circuit nearly identical to that used in **figure 3**. **Figure 4** shows the detectors and pre-amplifiers in a vacuum chamber. These tests were performed under computer (CPU) control by a program written in QUICKBASIC to interact with the DSO through a GPIB interface. Here, both SCA LL settings were set to only 1/3 the characteristic pulse-height because it was found that an α-split usually, but not always, maintains QM *particle-energy* conservation. By this we mean the "energy" read from the two detectors in coincidence usually adds to the emitted 5.5 MeV. The coincidence time-window was set to τ = 100 ns. The Δt histograms of **figure 5** were from DSO screen captures.

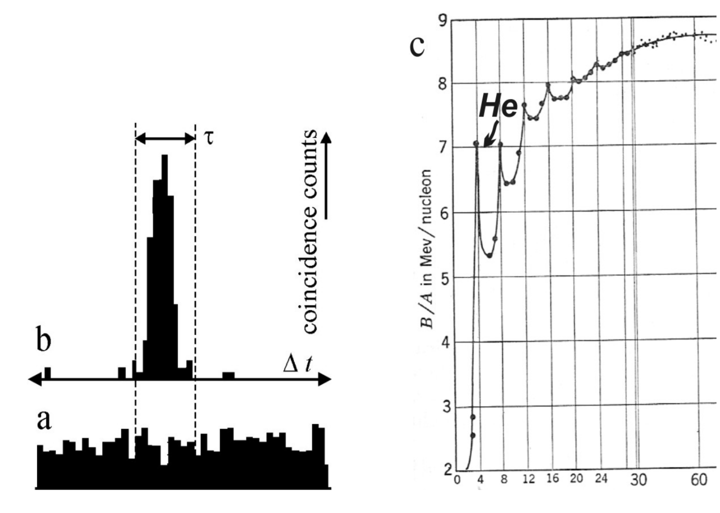

Figure 5. a: true-coincidence histogram. b: α-ray coincidence histogram. c: binding-energy per nucleon by atomic number.

Data of **figure 5-a** was a two-hour true-coincidence control test with the two detectors at right angles to each other and with the ^{241}Am centrally located. Only the chance rate was measured, assuring that only one α was emitted at a time. 4π solid angle capture was not attempted because it required a specially made thin source. However, the right angle arrangement is adequate and it is well known how ^{241}Am decays. Any sign of a peak is a quick way to see if chance is exceeded. A 48-hour background coincidence test with no source present gave a zero count.

Data of **figure 5-b** taken Nov. 13, 2006 was from the arrangement of **figure 4** using two layers of 24 carat gold-leaf suspended over the front of detector #1. Mounted at the rim of detector #2 were six 1 μCi ^{241}Am sources facing detector #1 and shaded from detector #2. Every coincident pulse-pair was perfectly shaped. R_c = 9.8 x 10^{-6}/s, and R_e/R_c = 105 times greater than chance.

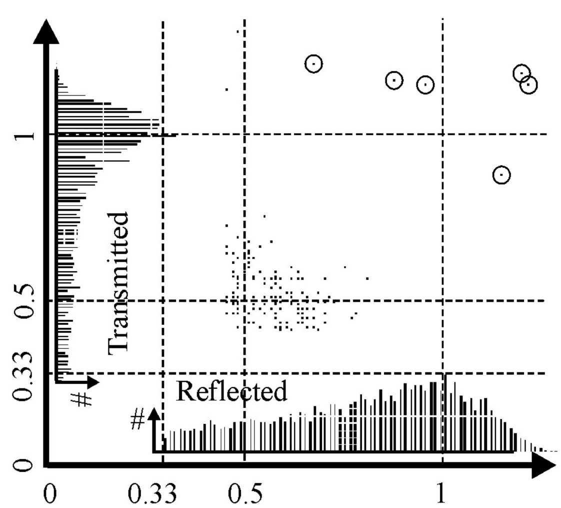

Figure 6. Data from computer-controlled experiment of figure 8 with pulse-height pairs on each detector plotted X-Y.

From collision experiments, the α requires ~7 MeV per nucleon to break into components, and even more energy is required to break gold [24]; see **figure 5-c**. It would take 14 MeV to create two deuterons. The only energy available is from the α's 5.5 MeV kinetic energy from spontaneous decay. Therefore, there is not enough energy to cause a conventional nuclear split. So even though the discriminator levels were set to allow half-heights, we are witnessing something extraordinary.

From the CPU program and data accumulated from the test of **figure 5-b**, data is re-plotted in **figure 6**. **Figure 6** depicts each pulse-height as a dot on a two-dimensional graph to show coincident pulse-heights from both detectors. The transmitted and reflected pulse-height singles spectra were carefully pasted from the DSO into the figure. We can see that most of the α pulses (dots) are near the half-height marks, demonstrating QM *particle-energy* conservation. However, the 6 dots circled clearly exceeded QM *particle-energy* conservation.

Counting just these 6, we exceed chance: $R_e/R_c = 3.97$. This is a sensational contradiction of QM because it circumvents the argument that a particle-like split, such as splitting into two deuterons, is somehow still at play. There are still particles. Tests by others have shown that the alpha can take on either a wave or particle state. Those tests plus ones described here reveal matter is a soliton.

History of the loading hypothesis and its misinterpretation

The revolutionary implication of these tests requires an accompanying historical and theoretical analysis. Lenard [7] recognized a pre-loaded state in the photoelectric effect with his trigger hypothesis. Interpretations of the photoelectric and other effects led most physicists toward Einstein's light quanta [25]. Planck [8, 9] explored a continuous absorption — explosive emission model in a derivation of his black body law. Sommerfeld and Debye [10] explored a model of an electron speeding up in a spiral around a nucleus during resonant light absorption. Millikan [12] described the loading hypothesis, complete with its pre-loaded state in 1947, but assumed that its workings were "terribly difficult to conceive." In our extensive search, all physics literature dated after Millikan's book considered only a crippled loading hypothesis with no consideration of a pre-loaded state.

Most physics textbooks [26] and literature [27] routinely use photoelectric response-time as evidence that an accumulation hypothesis (as they called it) is not workable. Effectively, students are taught to think there is no such thing as a pre-loaded state. Using a known light intensity, our textbooks will have you calculate the time required for an atom-sized absorber to soak-up enough energy to emit an electron. If one uses 10^{-10} m for the diameter of an atomic absorber, one finds a surprisingly long response (accumulation) time of about a minute. However, this is a *maximum* response time. Furthermore, the effective absorber size could be much larger than an atom, as understood by an extended charge and from antenna theory. Textbooks claim the calculated long response time is not observed, and often quote ~3 ns from the 1928 work of Lawrence and Beams [28] (L&B). This 3 ns is really a *minimum* response time. They unfairly compared a *minimum* experimental response time with a *maximum* calculated response time. If an absorber is pre-loaded to near a threshold, it would easily explain any minimum response time without resort to photons. A maximum response time was also reported by L&B, at ~60 ns. However, L&B did not report their light intensity, so it is not possible to use their results in a calculation. Energy conservation in-general must be upheld. Therefore the appropriate calculation would be in reverse order: measure the maximum response time and light intensity, assume the accumulation hypothesis starting from an unloaded state, and calculate the effective size of the loading complex. I describe similar misinterpretations elsewhere [29]. The loading hypothesis was the first and obvious model considered for our early modern physics experiments, and it was falsely represented.

A workable loading hypothesis

Here we describe our enhanced loading hypothesis we call the threshold model (TM). We treat TM for electron charge but it may be similarly developed for nuclear matter-waves using the appropriate mass constant. We contend that TM can explain conventional quantum experiments and our new unquantum experiments. We will justify these three assertions:

#1. In de Broglie's wavelength equation, we realize a group wavelength. The group is either a beat or a standing-wave envelope of Schroedinger's non-probabilistic wave function Ψ. Schroedinger denounced the probability interpretation of Born. Schroedinger talked of “deep difference tones” in his famous first QM paper. Solutions of the Schrodinger equation are envelopes and beats.

#2. Emission is quantized but absorption is continuous and thresholded. This is Planck's second theory of 1911.

#3. Planck's constant h, electron charge e, and the electron mass constant m_e are maximum thresholds (ER). When we see ratios like *h/e, e/m,* and *h/m* in our equations... action*,* mass*,* and charge need not be thought in terms of constants *h, m,* and *e.* The ratios are constant. This is emphasized in **figure 8**. This allows a matter-wave to expand and disperse, yet maintain its character upon loading-up at an absorber.

In de Broglie's derivation of his famous wavelength equation [30]

$$\lambda_\psi = h/(m_e \sigma_p), \tag{2}$$

he devised a frequency equation

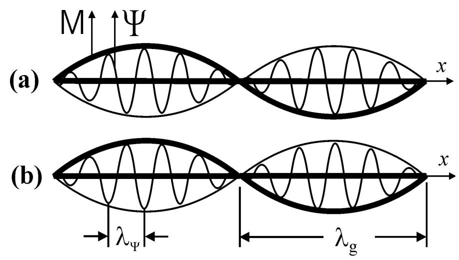

Figure 7. Matter and antimatter. (a) Two positron beats. (b) Two electron beats.

$$h\nu_\psi = m_e c^2, \qquad (3)$$

and a velocity equation

$$\sigma_p \sigma_\psi = c^2. \qquad (4)$$

For equations (2–4), subscript ψ (lower case psi) expresses a probabilistic wave, λ_ψ = phase wavelength, ν_ψ = phase frequency, σ_p = particle velocity, σ_ψ = phase velocity, and m_e = electron mass. Equations (3) and (4) were widely accepted, but have serious problems.

Equation (3) looks nice, but it is not true. Planck's constant in experiments does not relate to mass-equivalent energy; instead it relates to either momentum or kinetic energy. If we measure σ, λ, and m_e from matter diffraction, equation (3) fails. For kinetic energy it is proper to write $h\nu_L = m_2c^2 - m_1c^2$, as a frequency equation, but using this does not lead to a wavelength equation.

As for equation (4), one might attempt to extract it from the Lorentz transformation equation of time. Catastrophically, it describes an infinite σ_ψ in any particle's rest frame. Many physicists use equation (4) to justify the probability interpretation of QM [31], but that leads to "spooky action at a distance."

A more reasonable frequency equation for the electron than (3) is the photoelectric effect equation $h\nu_L = ½\, m_e \sigma_p^2$, where here we leave the work function not yet encountered. It is very reasonable to understand that something about charge is oscillating at the frequency of its emitted light, but just how to replace ν_L with a charge-frequency requires insight. Recall the Balmer or Rydberg equation of the hydrogen spectrum in terms of frequency and write it in its simplest form: $\nu_L = \nu_{\Psi 2} - \nu_{\Psi 1}$. Now we use subscript Ψ for a non-probabilistic matter-wave. The hydrogen spectrum is telling us that the relationship between ν_L and ν_ψ is about difference-frequencies and beats. Consider that this difference-frequency property is fundamental to free charge as well as atomically bound charge. Beats, constructed from superimposing two sine waves, are understood from a trigonometric identity, whereby an averaged Ψ wave is modulated by a modulator M, as graphed in **figure 7**. If we take M as the coupling of light to charge we see that there are two beats per modulator wave, and we can write a relationship between light frequency and the frequency of charge beats: $2\nu_L = \nu_g$; g is for group. Here we recognize group velocity in place of particle velocity, so let $\sigma_p = \sigma_g$. Substituting the last two equations into the photoelectric equation makes $h\nu_g = m_e\sigma_g^2$. Since groups are periodic we can apply $\nu_g = \sigma_g/\lambda_g$ to derive

	Quantum Mechanics	Threshold Model
Matter wavelength	$\lambda_{\text{phase}} = \dfrac{h}{m\sigma}$	$\lambda_{\text{group}} = \dfrac{Q_{h/m}}{\sigma_{\text{group}}}$
Photoelectric	$h\nu_L - h\nu_0 = \dfrac{m\sigma^2}{2} = eV_0$	$Q_{h/m}(\nu - \nu_0) = \dfrac{\sigma^2_{\text{group}}}{2} = Q_{e/}$
Compton	$\Delta\lambda = \dfrac{h\,(1-\cos\theta)}{mc}$	$\Delta\lambda_{\text{group}} = Q_{h/m}\,\dfrac{1-\cos\theta}{c}$
Lorentz force	$F = ma = e\,(\sigma \times \boldsymbol{B})$	$a = Q_{e/m}(\sigma_{\text{group}} \times \boldsymbol{B})$
Aharonov-Bohm	$\Delta x = \dfrac{e\,L\lambda Bw}{h}$	$\Delta x = Q_{e/h}\,L\lambda_{\text{group}}Bw$

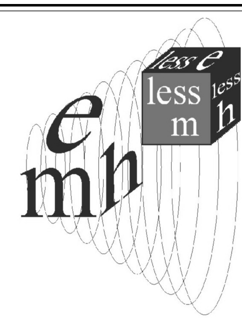

Figure 8. Equations describing wave-like effects by the Threshold Model.

a new wavelength equation, which is **assertion #1**:

$$\lambda_g = h/(m_e \sigma_g). \qquad (5).$$

Notice that both the photoelectric equation and equation (5) have h/m_e; see **figure 8**. Recall several equations applicable to wave properties of so called QM particles: de Broglie's, photoelectric effect, Compton effect, Lorentz force, Aharonov-Bohm effect. They all have ratios like *e/m, h/m, h/e*. In **figure 8**, all I am doing is relabeling like this: $h/m_e \equiv Q_{h/m}$, where Q is for quotient. In any chopped-out volume of an emitted charge-wave (electron), we can model that action is less than h, and mass is less than m_e. Therefore their ratios are conserved in any experimental test related to wave properties. There would be no way to determine if those values went below our thresholds h, m, e because we only measure their ratios. That substantiates **assertion #3**. Therefore we can write equation (5) as $\lambda_g = Q_{h/m}/\sigma_g$ and the photoelectric equation as $\nu_L = ½ Q_{h/m}\sigma_g^2$. At threshold, $m_{group} = m_e$, and at sub-threshold we can use our Q ratios to emphasize wave nature. Equations with higher powers of these constants are about how the wave holds itself together the way a classical particle would.

To understand the photoelectric effect without photons, visualize the pre-loaded state in the $Q_{h/m}$ ratio. Kinetic energy loads up to a threshold and an electron's worth of charge is emitted explosively (**assertion #2**). Thereafter the charge-wave can spread to infinity, yet maintain its character by **assertion #3**. To derive the photoelectric effect, do the derivation of the new wavelength equation (5) in reverse and apply the above 'ratio trick.' It is really nature's ratio trick.

The Compton effect is often claimed to require QM treatment. A classical treatment is plain to find in Compton and Allison's book [ref. 11, see p. 232]. They brilliantly recognized a Bragg grating made from beats of standing de Broglie waves. Their construct is problematic because their beats would be low-amplitude. This is easy to fix with **assertion #1**. Call the beat-length d in the Bragg diffraction equation $\lambda_L = 2d \sin(\phi/2)$, where ϕ is the x-ray deflection angle. Substitute into d, λ_g from equation (5). Solve for σ_g and insert into the Doppler-shift equation $\Delta\lambda_L/\lambda_L = (\sigma_g/c)\sin(\phi/2)$. Simplify using trigonometric identity $\sin^2\phi = (1 - \cos 2\phi)/2$ and use $Q_{h/m}$ to yield $\Delta\lambda_L = (Q_{h/m}/c)(1 - \cos\phi)$, the Compton effect equation. Also, related to the Compton effect are popular accounts of the test by Bothe and Geiger. Their measured coincidence rate was not a one-to-one particle-like effect as often claimed, but rather the coincidence rate was only ~1/11 [32].

What about quantized charge experiments? Measurements of e were performed upon ensembles of many atoms, such as in the Millikan oil drop experiment, and earlier by J. J. Thompson. An ensemble of thresholded charge-waves would strengthen a threshold effect to give the illusion of pure quantization. From evidence of charge diffraction alone, it was a poor assumption to think charge was always quantized at e. Charge, capable of spreading out as a wave with a fixed e/m_e ratio for any unit of volume, loading-up, and detected at threshold e, would remain consistent with observations. An electron's worth of charge need not be spatially small. Chemists performing Electron Spin Resonance (ESR) measurements often model an electron as large as a benzene ring. A point-like electron would predict a smeared-out ESR spectrum. This nature of the extended electron further explains an ensemble effect in a threshold model.

Detector clicks need not be evidence that a particle landed there. A way to visualize TM is by **Figure 9**. The following is a list of famous experiments and principles re-analyzed with TM and are elaborated in my works elsewhere [20, 30]: photoelectric effect, Compton effect, shot noise, black body theory, spin, elementary charge quantization, charge & atom diffraction, uncertainty principle, exclusion principle, Bothe-Geiger experiment, Compton-Simon experiment, and the nature of antimatter as envisioned in **figure 7**. Antimatter would have an internal phase shift. The TM supported by the unquantum effect easily resolves the enigma of the double-slit experiment. A light-wave or matter-wave would load-up, and show itself with a click upon reaching a threshold.

We conclude that light is always a wave and that matter can take on either of two states, like a soliton. A spreading elemental matter-wave would encode, by a detail resembling its conventional atomic spectroscopic signature, the ability to load itself up as an identifiable element at an absorber. No spooks. Our α-split test makes it reasonable to extend TM to all QM particles: charge-waves (electrons), neutron matter-waves (neutrons), and elemental matter-waves (atoms) [33, 34]. Consistent with our model is a recent helium diffraction experiment (by others) that revealed both particle and wave signatures in its diffraction pattern [35]**.** The matter-wave reads like a soliton that can either hold itself together in a particle state or spread like a wave. This is subtly different from complementarity, whereby the observed state would depend on how one 'looks' at it.

One may protest by quoting experiments in support of QM, such as giant molecule diffraction, EPR tests, and quantum cryptography. Analysis of major flaws in such tests, and elaboration of topics outlined here, are freely viewable from my posted essays, videos, and forums linked from www.unquantum.net.

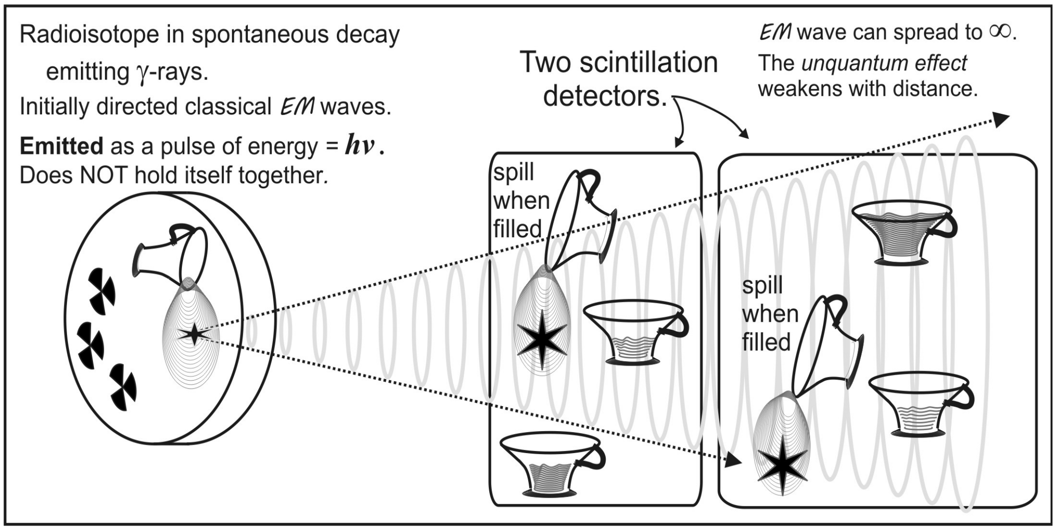

Figure 9. Visualization of the Threshold Model.

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