The Trouble With Quantum Mechanics is the Quantum

By Eric Stanley Reiter 2023

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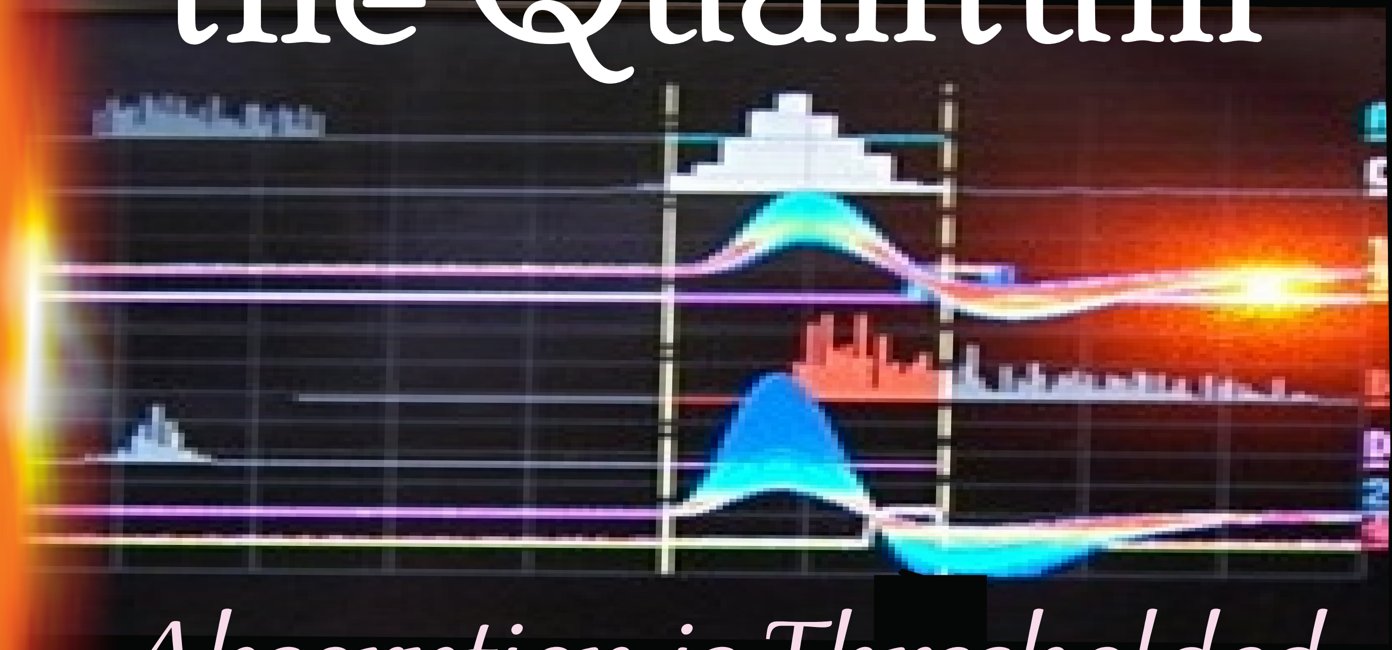

Absorption is Thresholded Not Quantized

By Eric Stanley Reiter

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The cover. This is an image from my digital oscilloscope showing pulses from two gamma-ray detectors in a beam-split coincidence experiment. The upper histogram shows the difference in time between the two detector pulses. By others, this same test was done with visible light and it only showed a flat histogram of noise, conforming to quantum mechanical chance. Mine are the only such tests performed with gamma-rays and are the only tests to deliver a distinctive peak. The peak shown indicates exceeding chance and refutes quantum mechanics. I show similar results with alpha-rays, thereby resolving the wave-particle paradox for both matter and light. My *threshold model* predicted these results. ER

Preface

This book has something for everyone. Chapters may be read in any order.

My best physics writing is the first chapter, a formal paper intended for a peer-reviewed journal. Physics has become a quantum club, and I am OUT. However, small peer-reviewed journals did receive me well: *Physics Essays*, *Progress in Physics*, and *Cosmos and History*. The editor of *Physics Essays* is an expert in the field who publishes and leads conferences; I presented at his Society of Photonics (SPIE) "Nature of Light: What Are Photons?" conference in 2015, and published there as well.

The second and third chapters are lecture slides I refer to when delivering lectures. The history of quantum mechanics **is** arguments for and against quantum mechanics. In **A Critical History of Quantum Mechanics** you see the actual images from influential books and papers of these arguments.

The **Photo Essays** reveal a small sample of apparatus I developed toward testing and perfecting *Photon Violation Spectroscopy* and *Particle Violation Spectroscopy*.

What if it is true, that I resolved such an important problem in physics? People will want to know: Who is this Eric Reiter? **The last chapter, Life and Works**, is informal, autobiographical, entertaining, and philosophical. See what it was like for a creative rascal in the vibrant work-live repurposed warehouse projects of 1970s San Francisco. Here I am showing off a lifetime of effort in art, music, alternative energy, living systems, electronics, physics, and biology.

My website www.thresholdmodel.com has all my published papers, videos, and two detailed patent applications on the utility of this physics (rejected of course). There are no secrets about me or my work. I worked 18 years to see if I got the physics wrong. It is right.

All details, people, and places are true. I am the lucky son of Sam and Ida Reiter of Brooklyn New York, b. 1950. Luckily, my simple film camera captured the older photos. ER 2023.

Contents

Note. A PDF of this book on www.thresholdmodel.com has active links.
A paperback book is on Amazon.com and is a good thing to have.

Gamma-ray Experiments, Explained By Planck's Loading Theory, Challenge Entanglement

Eric Stanley Reiter 2023

Abstract

Entanglement popularly relates to a two-particle test whereby properties of the two separated particles are correlated. A simple and more fundamental test for the investigation of entanglement is a one-particle test, also called a beam-split coincidence test. Flaws in performing these tests with visible light detectors and other criticisms of prior art are described. Here are shown beam-split coincidence tests using singly emitted gamma-rays from radioisotopes in spontaneous decay, and similarly shown with alpha-rays. The data of beam-split coincidence tests are histograms of time-difference between detector clicks. In prior art, the histograms were bands of noise due to chance, seemingly confirming quantum mechanics (QM). New here are histograms with robust peaks, greatly exceeding chance, contrary to QM. Exceeding QM chance is the same as seeing a two-for-one effect in the test, not at all understood by energy quantization. Embracing energy conservation, the experiments say that an underlying unquantized component must exist in the detector prior to reaching a threshold. This evidence calls for a threshold model (TM), an enhancement of a loading theory first explored by Planck in 1911. TM treats familiar constants e, h, and m as maxima, whereby sub-maxima are hidden, yet maintain conserved ratios of charge, action, and mass. In equations of spreading matter-wave effects, the experiments only deliver these quotient values: $Q_{e/h}$, $Q_{h/m}$, and $Q_{e/m}$. It is the quotients that remain quantized. In the photoelectric effect, a particle-like effect can occur upon action reaching threshold h to give the illusion of an incident photon. Assuming no flaw in experiments described here, implications of quantum mechanics such as entanglement will be recognized as an illusion.

Keywords

Quantum entanglement, measurement problem, wave-particle duality, superposition, reduction of wave packet, nonlocality, loading theory, matter waves, threshold model.

1. Introduction

Entanglement is usually understood from a two-particle test, but its theoretical underpinnings are best described with a one-particle test. The one-particle test is a beam-split test and will be referred to that way herein. The term "particle" used here was only for the reader's convenience to represent the two kinds of tests in the familiar quantum mechanical context. The beam-split test is also an entanglement test in that a detector click down one path is thought to be entangled with the other-path detector to eliminate, on average, a simultaneous click, by energy quantization. A click is a processed detector pulse assigned an energy $h\nu$ (ν=Greek *new*=frequency). A succinct description of the photon model and this beam-split kind of entanglement is described by Bohr [1] relaying Einstein's model:

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

Einstein's model is similarly described by de Broglie [2] and Heisenberg [3]. The formalism of quantum mechanics (QM) deals with averages in an ensemble, but this photon model reveals the important effects in three parts: an initial single photon assumption, an OR effect, and an AND effect. The photon

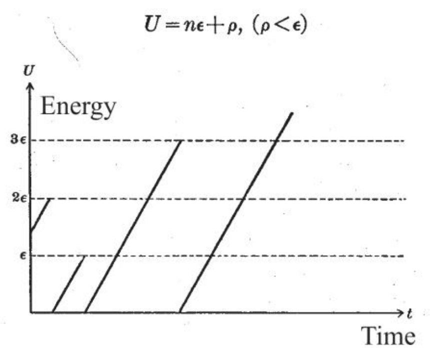

Figure 1. Planck's loading theory. From *The Theory of Heat Radiation*, page 161 [8]. $\varepsilon = h\nu$. Energy, Time annotated.

assumption implies an initial single $h\nu$ of energy quantized in space. The OR effect is about a particle-like detection occurring one way OR another past the beam-split. This is the beam-split test mentioned above and is the emphasis of experiments in this essay. If energy is quantized by $h\nu$, and ν is unchanged at the detectors, the OR effect must happen, at least on the average. The AND effect is about how a wave, associated with its originating $h\nu$, must go this way AND that way past a beam-split to create an interference pattern from many absorbed $h\nu$ over time. Even though the OR and AND effects are different experiments, they both happen past the beam-split. Some declare a problem, and others deny a problem, in endless arguments over this OR–AND contradiction. The formality of QM usually handles that OR–AND situation with a non-physical probability wave that instantaneously disappears upon absorption of the single $h\nu$. The described QM effects are thought to occur with matter as well as light.

Beam-split tests of QM were performed by others using visible light [4][5][6] and x-rays [7]. We aim to measure a violation of *quantized energy conservation* while embracing energy conservation in general. We realize this idea requires re-thinking many experiments; the long history of particle physics associates conservation with quantization. There is a way to avoid energy quantization, embrace $Energy = h\nu$, and maintain energy conservation. That way is inspired by Planck's second theory of 1911 [9], whereby h is now interpreted as a maximum of action in matter. In this model, action can be less than h, but its sub-h value remains hidden. This model was also explored by Debye and

Sommerfeld [10]. Planck understood a pre-loaded state, whereby his black body spectrum equation can be derived from assuming continuous absorption and explosive emission [9][11], as in **Figure 1**. This old alternative to QM is called the loading theory.

In the beam-split test, detector clicks generating an experimental coincidence rate R_e are compared to a coincidence rate expected by accidental chance R_c. QM calls for R_e/R_c to not exceed unity [4]. If singly emitted $h\nu$'s cause two full $h\nu$'s at detectors in a two-for-one effect, as described below, it implies a loading theory and failure of QM. We call $R_e/R_c >> 1$ a threshold effect. We will explain how this is possible for both matter and light with our enhanced loading theory, the threshold model, TM.

2. Problems With Previous Beam Split Tests

In a clear distinction test between QM and TM, the detection mechanism must adequately handle both time and energy for each click in a beam-split coincidence test with two detectors, as shown in the following analysis. In **Figure 2**, pulse height response from visible monochromatic light upon a photomultiplier tube (PMT) [12] is compared to pulse height response of 88keV γ-rays upon a sodium iodide scintillation detector. This is the same γ-ray source and detector used in our beam-split test described below. On the horizontal axis is pulse height, also called pulse energy. The γ-ray detector has pulse height resolution, known from other tests to be roughly proportional to electromagnetic frequency. Conventional graphs express photon

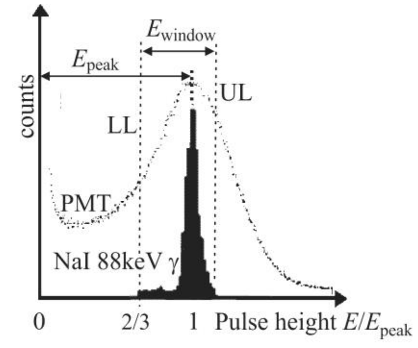

Figure 2. Pulse heights from visible monochromatic light upon a PMT compared to pulse heights from 88keV gamma-rays upon a NaI(Tl) scintillator.

energy, but we distinguish between a quantum of energy in light and threshold energy upon detection.

In γ and visible sources, the experimenter will use a single channel analyzer (SCA) filter instrument that outputs square clicks in response to a window of pulse heights E_{window}. LL is lower level, and UL is upper level of this window. We used Ortec 460 Delay Line Amplifier and Ortec 551 Timing SCA in our experiments.

The PMT responding to monochromatic light needs no frequency resolution, but it requires an SCA to remove smaller noise pulses. No one seems to report this noise-floor setting. For the PMT, if LL is set to less than ½ E_{peak}, one could argue that TM is favored (against photons) because noise pulses or a down-conversion might take place to increase coincidence counts. Also for the PMT, if LL is set higher than ½ E_{peak}, one could argue that photons are favored (against TM) by eliminating pulses that would generate coincidences by the threshold effect. It already looks impossible to use visible light, but let us elaborate.

From considering a classical γ-ray in the threshold model, we adjust our tests to see the two-for-one effect. Energy pre-loaded in the detector comes from previous γ or noise. LL must be set higher than ½ E_{peak} to determine if an emitted $h\nu$ energy would generate detector clicks, such that the energy of the two detectors past the beam-split would add to near twice the emitted $h\nu$. We must avoid the possibility of counting pairs of half-height (half-energy) detector pulses to preserve our claim that the threshold effect could exceed *quantized energy conservation*. To give TM a fair chance to exceed noise and see the two-for-one effect, pulse height resolution with $E_{\mathrm{peak}} >> E_{\mathrm{window}}$ is required as shown in **Figure 2**. This energy resolution cannot be accomplished with any visible light detector, even with cooling. These concerns are not addressed in the usual context of testing the photon model.

Another problem with prior art tests [4][5][6] is that polarized light will be routed one-way-OR-another by polarizing optics, especially by beam splitters. Yet another problem is that some photodetectors have dead time which can remove coincident responses.

With visible light, the means of attempting to generate single $h\nu$'s ahead of the beam-splitter use triple coincidence, which by its nature blurs the result toward chance. Those tests are complicated, depend on controversial assumptions, or both.

In the tradition of upholding γ-rays as the most particle-like light, it may seem wasteful to attempt a test to see if γ-rays are not like particles at all. However, all problems mentioned above are avoided by using γ-rays. With γ-rays, it is easy to deliver a singly emitted $h\nu$. Such γ occurs from a few usable radioisotopes in spontaneous decay. To determine single-emission, laboratories use a highly respected true coincidence technique relying upon the chance equation [13]. Even though the properties of these radioisotopes are well known, the true-coincidence test was performed in-house to be sure there was no contamination. The test has the isotope sandwiched between two detectors to read the experimental coincidence rate R_e and compares that to an accidental chance rate R_c, measured and calculated by

$$R_c = R_1 R_2 \tau \qquad (1)$$

where R_1 and R_2 are the measured singles rates from each detector and τ is a chosen time window within which coincident pairs for R_e are counted. R_c was also measured directly to test equation (1). In the true-coincidence test, if R_e nearly equals R_c, everyone agrees that the source emits one-at-a-time, meaning an atom in spontaneous decay emits only one γ-ray. It is also known that γ are directional like needle radiation. If $R_e > R_c$, the isotope emits more than one $h\nu$ per decay and is not useful in beam-split tests of QM. A flat band of noise in the true coincidence Δt histogram (see **Figure 4**) is a quick way to see that emissions are one-at-a-time, which is $R_e \approx R_c$.

3. Beam-Split Test Using Gamma-Rays

The true coincidence test tells us that whole singular $h\nu$ can be emitted and whole singular $h\nu$ are detected. The goal is to determine if energy remains quantized by $h\nu$ in space past the beam-split, and if there is a pre-loaded electronic state at the detector, and indeed in everything. By TM, a γ is *emitted* with energy $h\nu$, but thereafter the pulse of energy spreads classically.

In the transition from the true coincidence test to the beam-split test, the detector geometry is changed, but SCA levels and instrumentation remain unchanged. Therefore, our method compares two steps: step #1 tests for our source delivering one-at-a-time; step #2 looks for two-at-a-time resulting from this straightforward change in detector geometry. Of course, there are additional steps that measure and subtract background coincidence rates. In prior art beam-split tests, the evidence of QM was merely noise from chance, with $R_e \approx R_c$. No prior art beam-split test was attempted with γ-rays.

Figure 3 describes one test with γ, but many variants successfully exceeded QM chance. From many tests, we found that selecting the γ frequency and detector type, so that photoelectric effect efficiency exceeds Compton effect efficiency, will enhance exceeding QM chance. The single 88 keV γ emitted in spontaneous decay from ^{109}Cd, detected with NaI(Tl) scintillators, satisfies this criterion [14]. Few radioisotopes emit only one γ upon atomic decay, have a reasonable half-life, and have high photoelectric efficiency in commonly used detectors. This partially explains why exceeding QM chance was not previously discovered. After spontaneous decay by electron capture, ^{109}Cd becomes stable ^{109}Ag. ^{109}Cd also emits an x-ray, but it is below our LL setting.

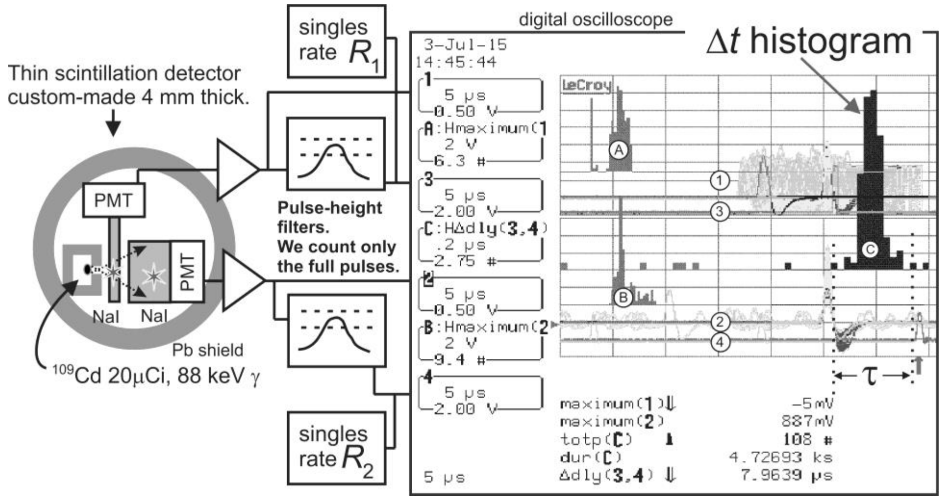

Figure 3. Gamma-ray beam-split coincidence test with two detectors in tandem. Oscilloscope is LeCroy LT344 with histogram software.

The beam-split test can resemble either a beam-splitter or two detectors in tandem. **Figure 3** shows tandem, a thin detector in front of a thick detector, which works best. The thin detector serves to tap away a fraction of γ energy, similar to what would happen in beam-split geometry. The thin detector is only 4mm thick and was generously custom-made by Rexon Components Inc. This custom detector is NaI(Tl), but several other detector/source combinations have proved effective, as outlined in Photon Violation Spectroscopy [15]. Tl indicates thallium doped. The second detector is two inches in diameter. Each detector is a NaI(Tl) scintillator crystal coupled to a PMT. A lead box collimates ^{109}Cd γ in an optimal path through both detectors, as shown in **Figure 3**.

Knowing that electromagnetic frequency is related to our pulse heights, the γ frequency will be conserved in our pair of coincident clicks. To avoid counting some form of down-conversion, LL was set on each SCA to near 2/3 the characteristic pulse height of the singly emitted 88keV γ, as shown in **Figure 2**. The coincidence rate caused by background radiation is usually significant and must be subtracted. With no source present and τ = 500ns, this coincidence background test had 304 counts/49.4ks = 0.00615/s. The same time window τ is used in four cases: true coincidence test, coincidence background test, coincidence test with the source, and chance calculation.

With the source present, the chance rate from Equation (1) was R_c = (8.21/s)(269/s)(500 ns) = 0.0011/s. The experimental coincidence rate counted within τ was R_e = (108/4.73ks) − (0.00615/s) = 0.0167/s. The threshold effect appears as R_e/R_c = 0.0167/0.0011 = 15. This defies energy quantization. Any peak in the Δt histogram, as seen in **Figure 3**, is all one needs to realize that QM chance is exceeded [5]. No such peak in any beam-split test with a one-at-a-time source has preceded this work.

Hundreds of beam-split tests with γ-rays were performed by us since 2001. Many tests were performed [15] to eliminate the possibility of artifacts from faulty instruments, contamination by ^{113}Cd in ^{109}Cd, lead fluorescence, cosmic rays, γ-ray stimulated emission (we did not discover it), pile-up errors, and PMT echo artifacts. Tests with an Odin coil were performed to eliminate the possibility of faulty pulses introduced by electromagnetic interference.

The threshold effect with ^{109}Cd is not a special case. Tests [15] revealing the threshold effect were performed with different sources (^{109}Cd, ^{57}Co, ^{241}Am, and with ^{22}Na in an annihilation radiation triple coincidence test [18]), different detectors (NaI(Tl), HPGe, bismuth germanate, CsI), various geometries, different beam-split materials, and different collimator materials.

If γ can split in two, they can split in three or more, and this was observed in two different tests [16].

The threshold effect was enhanced by a lower temperature beam-splitter as expected [15]. Upon cooling an aluminum beam-splitter with liquid nitrogen, the threshold effect was enhanced 50%.

Magnetic effects [15] were explored with coincident pulse height analysis in beam-split geometry. A ferrite scatterer when in a magnetic gap revealed enhanced coincident Rayleigh scattering, indicating a stiff electronic scatterer, as one would expect. A diamagnetic scatterer when in a magnetic gap revealed enhanced coincident Compton scattering, indicating a flexible electronic scatterer, as expected.

Threshold effect γ diffraction crystallography was discovered [15] by rotating a silicon crystal and comparing the effect; a calculation revealed diffracting from charge layers, not atomic layers. The magnetic and crystallographic threshold effects reveal electronic properties in atomic bonds.

Experiments with metallic and powder chemical states of ^{109}Cd modulated the threshold effect [15]. The threshold effect seems to reveal a wave property of the γ-ray, perhaps coherence, as a function of the chemical state of the emitting isotope.

Initial beam-split tests with the 'hotter' γ of ^{137}Cs failed to exceed QM chance. However, a series of tests [15] found that increasing the distance between the ^{137}Cs source and the detector pair led to success. A calculation revealed a match between the classical electromagnetic cone's diameter and the detector's atomic spacing.

The ways the threshold effect varied as a function of physical condition all made sense by classical properties of γ-rays and were all discoveries. The tests take advantage of a classical shock wave to reveal an unquantized pre-loaded state in a loading theory. Many of these tests were predictions of the threshold model.

An easy test of the threshold effect is to use only a single NaI (Tl) detector to examine sum-peaks in a pulse height spectrum. If two γ coincidently overlap in the detector, it produces a twice-high detector pulse and a spectral sum-peak. This overlap is supposed to not exceed the chance rate, which is easily measured.

With singly emitted γ from ^{57}Co, the sum-peak was measured at twice that expected from chance [15], which we take as evidence of the threshold effect.

4. Beam-Split Test Using Alpha-Rays

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 instead, consider a helium nuclear matter-wave. If the wave were probabilistic, the particle would go one way or another at a beam-splitter, and coincidence rates would approximate chance. Many and varied tests exceeding chance [18] were performed in four vacuum chamber rebuilds in search of artifacts and to perfect the technique. One test is described next in detail.

Figure 4 describes the test and data from November 13, 2006 [18]. Two 1-inch diameter silicon Ortec surface barrier detectors with good pulse height resolution were employed in a circuit nearly identical to that used in **Figure 3**. These tests were performed with data gathered under computer control by a program written in QUICKBASIC to interact with a LeCroy LT344 oscilloscope through a GPIB interface.

Here, both SCA LL settings were set to only 1/3 the characteristic pulse height because it was found that half-height pulse pairs usually appear in a coincident α-split. To split α in a conventional sense requires 7MeV per nucleon [20], but there are only 5.5MeV of kinetic energy from ^{241}Am decay. It would take 14MeV to create two deuterons or two of any fragments.

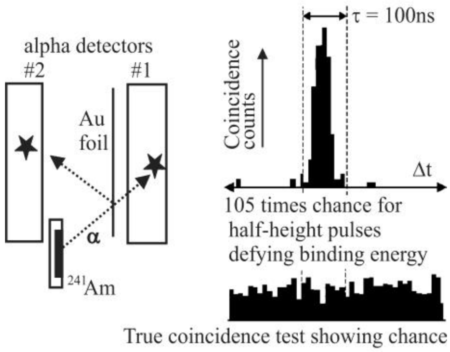

Figure 4. Alpha-ray beam-split coincidence test.

Two layers of 24-carat gold leaf were suspended over the front of detector #1. Mounted at the rim of detector #2 were six pieces of 1μCi ^{241}Am sources facing detector #1 and shaded from detector #2. Every coincident pulse pair was perfectly shaped. A two-hour true-coincidence control test is shown in **Figure 4** for these α tests. ^{241}Am is known to decay to ^{237}Np and also emit an α upon its decay, but its half-life being 2.14x10^6y makes it an unlikely problem. Our true coincidence test showing no peak means this source can be trusted to emit only one-at-a-time. A 48-hour background coincidence test with no source present gave a zero count. With the ^{241}Am present in beam-split geometry, allowing these half-height pulses, the chance calculation gave R_c = 9.8 x 10^{-6}/s, and the coincidence test compared to chance gave R_e/R_c = 105 times chance in defying binding energy.

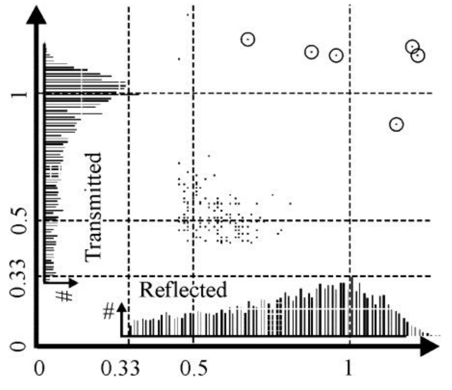

Figure 5. Alpha-ray beam-split coincidence data. Full-height pairs are

Figure 5 depicts a further analysis of the same test, plotting each pair of coincident pulse heights as a dot on a two-dimensional pulse height graph. The transmitted and reflected pulse height singles spectra from the oscilloscope were carefully pasted into the figure. Most of the α pairs (dots) are near the half-height marks. However, the six circled dots clearly exceed *quantized energy conservation*. Counting just these 6 exceeds chance at R_e/R_c = 3.97. Therefore, these are not atoms guided by probability waves. This is evidence of sub-quantum mass. Successful chance-exceeding splits by reflecting α from diamonds were also measured [18].

5. Threshold Model

The loading theory has always been the alternative to QM, as explored by Planck, Debye, Sommerfeld, and Millikan. Millikan [21] described the loading theory, complete with its pre-loaded state in 1947, but stated that its workings were "terribly difficult to conceive" [22]. Most physics textbooks [23] and some respected books [24] use short photoelectric response time as evidence that the loading theory is not workable. Textbooks have the reader calculate the time required for an atom absorber the size of the lattice to soak up enough energy to emit an electron. The authors have the reader compare your long calculated time to a short 3ns time, as measured by Lawrence and Beams [26]. They did not acknowledge a pre-loaded state which would have allowed the student to realize arbitrarily short times, similar to that 3ns. Also, L&B reported much longer response times, consistent with a loading theory. The loading theory allows for a hidden value in a pre-loaded state to exist that requires only small additional energy to complete loading to the threshold. Contrary to popular arguments, a short response time does not justify a photon model and does not eliminate a fair loading theory. A similar misunderstanding of short response times accompanied the Compton effect [15].

Compton's derivation (Debye also) of his effect using conservation of particle momentum is often cited as convincing evidence of light quantization. A wave derivation using Bragg diffraction and Doppler shift is in the very book by Compton and Allison [27]. Their wave derivation was not embraced, perhaps because their way of assuming standing charge-waves was clumsy. **Figure 6** revisits the same set of equations Compton and Allison used, but now we assume that charge-wave beats are a fundamental property of charge.

This beat model is also justified by a simple derivation linking the de Broglie relation to the photoelectric effect [15]. Balmer's 1884 equation for the hydrogen spectrum has the form of the difference between two terms equal to a frequency. In its simplest form, the equation is about difference frequencies. Difference frequencies say charge is made of beats between two inner Ψ waves, as Schrödinger discussed in his first famous paper: "…beats…deep difference tones…" [28]. In this model, charge is the envelope of Ψ. TM has light fitting charge beats in the photoelectric effect and Compton effect. Use $v = \nu\lambda$ to attempt a derivation of the photoelectric (PE) equation from de Broglie's wavelength relation $h = mv\lambda$, or vice-versa [16]. By redefining λ as the length of a matter-wave beat, an important factor-of-two correction emerges. This links a frequency equation (PE eq.) to a wavelength equation. Light fits a modulator wave M in **Figure 6** by a trigonometric identity.

The problem remained that wave and particle terms were in the same equations. My method is to respect the message of key experiments before borrowing constants from other experiments. The messages of PE and charge diffraction experiments deliver only *quotient values* h/m and e/h. TM applies

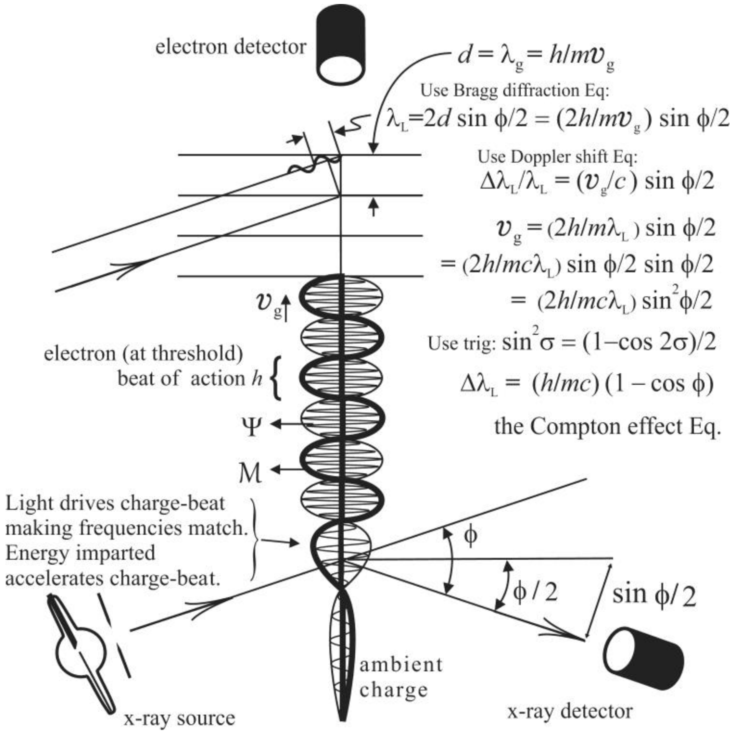

Figure 6. Wave derivation of the Compton effect equation

similarly to the e/m ratio. Expanding on Planck 1911, consider interpreting our constants e, h, and m in wave equations to be thresholds instead of being quantized. The quotient values charge/action, action/mass, and charge/mass are what are measured. The quotients are conserved constants. To explain the effect of exceeding QM chance, there must be a hidden sub-threshold existence to maintain matter-energy conservation. This way, a non-probabilistic matter-wave can spread, maintain its conserved quotient properties, and then load up to identifiable thresholds upon absorption. "Identifiable," as in helium diffraction experiments can detect helium at the detection plane. "Identifiable," as in (kinetic energy threshold) $= mv^2/2 = h\nu$ in the photoelectric effect. If an equation has more elaborate powers of constants e, h, or m or no simple ratio as described, then the equation is about how the matter-wave holds itself together in its classical particle state.

Figure 7 simply expresses some key equations related to spreading electronic charge-waves, now written with quotients like $Q_{e/m}$ of our familiar constants, to emphasize the message of the experiment indicated. The graphic depicts an *initially* quantized emission of charge that spreads as a wave toward the right. The cube indicates an arbitrary volume of a charge-wave, now containing unmeasurable sub-quantum values of charge, mass, and action in conserved ratios. Only the quotients (ratios) are measurable in free space tests. By TM, in equations relating to matter-waves, there are three conserved quotients with values h/m, e/m, and e/h.

Tests to decipher the charge constant e have employed large ensembles of atomic charges, such as oil drop tests, and did not rely on h and m. Consider that sub-e values of charges would be suppressed under the influence of many atoms in an ensemble, whereby only the threshold value e will be expressed. An ensemble test will reveal threshold value e that *looks* like charge is quantized. Oil drop tests with immense surface charge effects on microscopic spheres will express threshold e. Where we see wave properties in free space, the quotient principle removes the necessity to quantize charge in general. Charge held at threshold does not threaten charge conservation. High energy reactions will express themselves at the threshold to look quantized.

Similarly, tests to determine h, independent of e and m, are performed in large material ensembles such as black body tests. An ensemble test will reveal threshold value h that *looks* like action is quantized. The quotient structure of experimental wave equations reveals how action can be held at a threshold and then released, instead of quantized.

Electron mass m came from JJ Thomson's e/m, and then by applying Townsend and JJ's determination of e (historically). Electronic mass is never measurable in charge-wave experiments, independent of charge or action.

If we were unaware of the hidden threshold and ratio properties described above, nature would look like quantization and entanglement. When thresholds are reached, our detectors respond as if a particle hit there. One might protest by saying: "It makes no sense to try to describe what is not observed in nature." A good hypothesis can postulate what has not yet been observed. However, we do observe a quantum-defying effect in my many experiments. My experiments are simple. They are simple enough for an undergraduate student of nuclear physics to reproduce, given only the description portrayed here. Also, our very witness to wave-particle duality is a form of observation of the threshold model described here. Those wave effects in the context of QM imply ghostly entanglement.

Spin is a good example of how nature responds at thresholds. I am **not** saying we should see fractional spins, actions, charges, or masses, directly. We will not. The threshold model is about how nature hides the sub-threshold state. I had to perfect the theory ahead of time to strategize how to uncover that hidden nature.

A respected experiment showed that a concentric grating of slits could focus helium and, at the same receiving plane, it also indicated a classical particle trajectory [29]. The message from that test combined with the message of our alpha-ray experiments says that atoms are solitons. A soliton is a two-state system that can either hold its internal waves together as a classical particle or can disperse like a wave when traveling in free space. In its wave state, mass can exist sub-threshold by the conserved quotient principle described above. Such sub-threshold mass in the beam is not measurable because the equation dealing with its measurment has a conserved quotient; one will measure the charge/mass ratio, for example. The threshold model offers a different way of thinking about our key experimental equations, leaving the equations mostly intact, as shown in **Figure 7**.

Please realize that the conserved ratio construct is only applicable to experiment-equations with those simple ratios. Equations with mixed powers are for classical particles or for bulk matter in ensembles. From the above experiment [29] we can see that helium can take on a classical particle state. This brings up a new predictive power of the threshold model. The structure of the

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

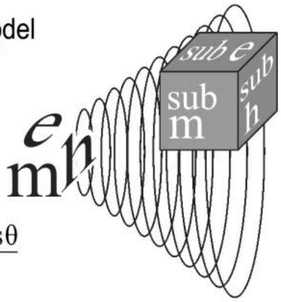

Figure 7. Wave-property equations re-expressed with *Q*'s as the message of key experiments.

equation tells us that spectral properties of the particle-state-beam should be observed, but not in the wave-state-beam. Our threshold model is explanatory and predictive. I already demonstrated its predictive power with the experiments described here and those in references [15] and [18].

Briefly, applying this beat/quotient/threshold model also led me to i) a derivation of the Planck normal spectrum equation using Bose's h^3 construct upon three superimposed dimensions of material action-beats, ii) an analysis of the Stern Gerlach experiment, iii) a model of spin as counter circulating Ψ waves, iv) modeling how space-filling charge beats leads to the exclusion principle, v) a model of antimatter with light fitting beats in the opposite phase, and vi) modeling how opposite phases of beats cancel in pair annihilation. This is all elaborated on the author's published papers and VIXRA.

6. Conclusion

It was natural for JJ Thomson to assume the particle model to decipher the charge constant e and the e/m ratio. Then came Einstein's "heuristic" light quanta [30], causing much debate. When JJ's son GP revealed charge diffracting, and Estermann and Stern diffracted helium, "wave properties of particles" were undeniable. If a particle was modeled as a wave packet the size of several diffracting layers, reduction of a microscopic wave packet might be understandable. Soon Born's probability interpretation of Schrödinger's Ψ*Ψ was taken to explain macroscopic as well as microscopic wave packet reductions. Schrödinger strongly argued against Born probability [31] and its inescapable implication of nonlocality. Einstein effectively did an about-face from his 1905 light quanta by arguing against reduction of the wave packet in the EPR paper [32]. The authors of EPR were quite correct to recognize the problem but they admitted they did not have a fix. Our method of using thresholds and conserved ratios eliminates the reduction of the wave packet, which in turn eliminates nonlocality and entanglement.

It is easy to think that particles and entanglement are at play if nature only responds at thresholds and maintains conserved ratios, especially if we are unaware that such hidden properties might exist. Our gamma and alpha experiments are easy to reproduce, and all details are disclosed in the references. A detailed video of the gamma experiment is posted where one can see dimensions of the test. If others perform the gamma beam-split tests and experience results as stated here, worldviews informed by quantum mechanics will be recognized as illusions.

Acknowledgments

Kenneth Kitlas, Michael Kan, Robert Alan Wolf, and Miriam Reiter helped in many ways.

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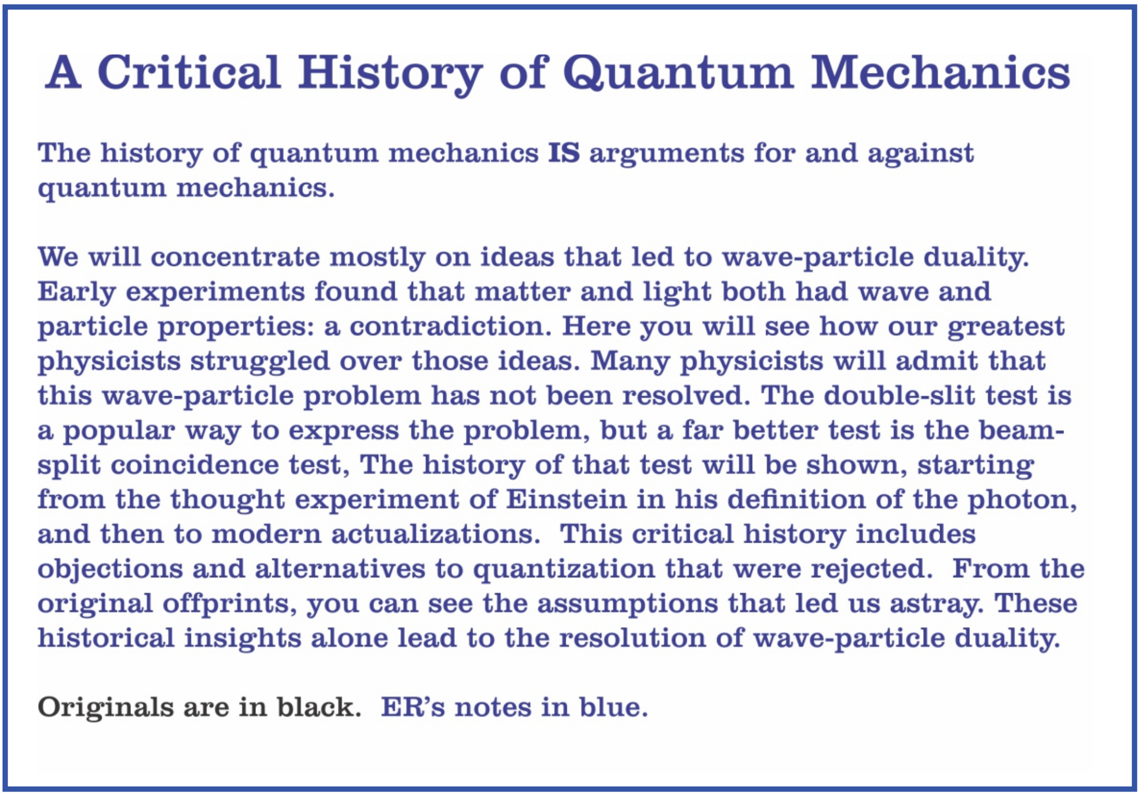
Lecture slides



A Critical History of Quantum Mechanics

The history of quantum mechanics **IS** arguments for and against quantum mechanics.

We will concentrate mostly on ideas that led to wave-particle duality. Early experiments found that matter and light both had wave and particle properties: a contradiction. Here you will see how our greatest physicists struggled over those ideas. Many physicists will admit that this wave-particle problem has not been resolved. The double-slit test is a popular way to express the problem, but a far better test is the beam-split coincidence test, The history of that test will be shown, starting from the thought experiment of Einstein in his definition of the photon, and then to modern actualizations. This critical history includes objections and alternatives to quantization that were rejected. From the original offprints, you can see the assumptions that led us astray. These historical insights alone lead to the resolution of wave-particle duality.

Originals are in black. ER's notes in blue.

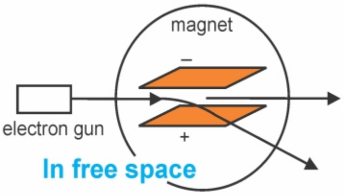
Contents

In red not accepted by mainstream.

1897 JJ Thomson used the particle model in experiment and theory to reveal

e/m ratio

by Lorentz force.

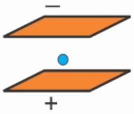


In free space

1898 Later JJ and others balanced liquid drops to reveal the charge constant

e

balance
liquid drops
against
gravity



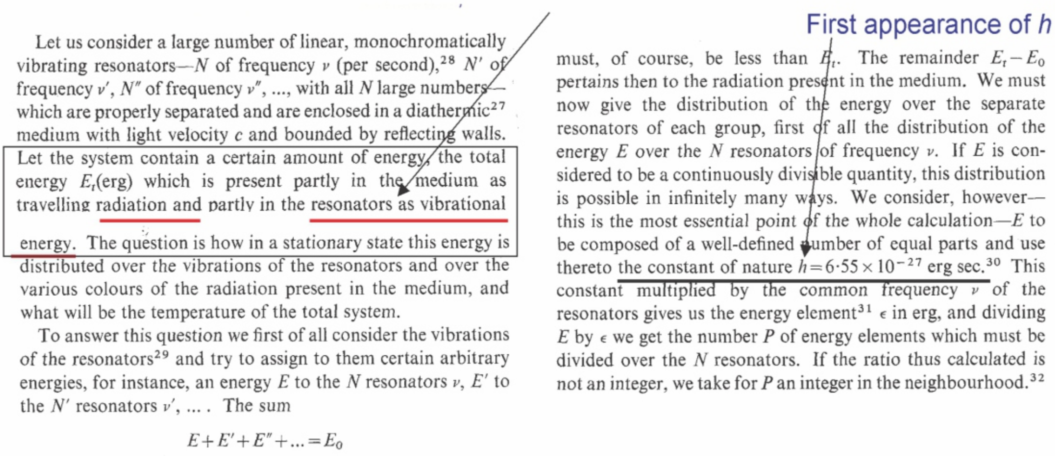
In bulk matter

Assumption: Charge was thought to be quantized and particle-like in free space, even though our experiments only reveal ratios like e/m in free space.

Consider that charge is thresholded and that a bulk matter ensemble effect obscures sub-threshold detection. If only the e/m ratio is quantized, there can be sub-thresholds of charge in sections of space and our experiments would not detect it. At www.thresholdmodel.com you will see how beam-split coincidence tests verify this model.

1900. Planck, *On the Theory of the Energy Distribution Law of the Normal Spectrum*,

Meeting of 14 December 1900. In *Planck's Original Papers in Quantum Physics*, Kangro, Brush 1972.
Not about quantizing light. Here the energy was in matter and light.



First appearance of *h*

Let us consider a large number of linear, monochromatically vibrating resonators—N of frequency ν (per second),[28] N' of frequency ν', N'' of frequency ν'', ..., with all N large numbers—which are properly separated and are enclosed in a diathermic[27] medium with light velocity c and bounded by reflecting walls. Let the system contain a certain amount of energy, the total energy E_t(erg) which is present partly in the medium as travelling radiation and partly in the resonators as vibrational energy. The question is how in a stationary state this energy is distributed over the vibrations of the resonators and over the various colours of the radiation present in the medium, and what will be the temperature of the total system.

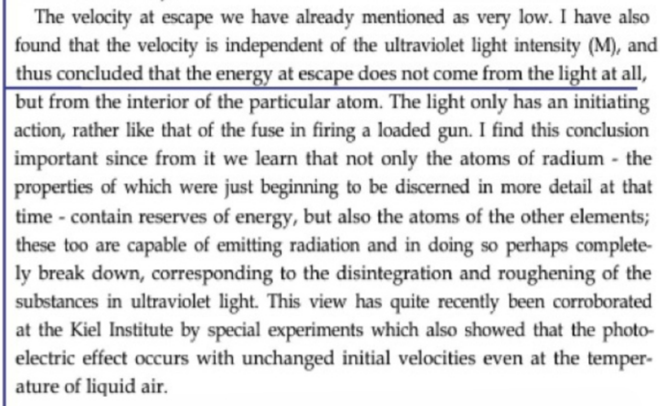
To answer this question we first of all consider the vibrations of the resonators[29] and try to assign to them certain arbitrary energies, for instance, an energy E to the N resonators ν, E' to the N' resonators ν', ... The sum

$$E+E'+E''+\ldots=E_0$$

must, of course, be less than E_t. The remainder E_t-E_0 pertains then to the radiation present in the medium. We must now give the distribution of the energy over the separate resonators of each group, first of all the distribution of the energy E over the N resonators of frequency ν. If E is considered to be a continuously divisible quantity, this distribution is possible in infinitely many ways. We consider, however—this is the most essential point of the whole calculation—E to be composed of a well-defined number of equal parts and use thereto the constant of nature $h=6{\cdot}55\times10^{-27}$ erg sec.[30] This constant multiplied by the common frequency ν of the resonators gives us the energy element[31] ϵ in erg, and dividing E by ϵ we get the number P of energy elements which must be divided over the N resonators. If the ratio thus calculated is not an integer, we take for P an integer in the neighbourhood.[32]

1902 Lenard. *Uber die Lichtelektrische Wirkung*, Annalen der Physik, 313(5), pg 149. Lenard understood in the photoelectric effect how the kinetic energy of the emitted electron was proportional to the light frequency. His idea was half correct in my (ER) view in that a resonance would release stored energy. It was rejected because he was explaining in terms of an atomic storage instead of an electronic storage. We will see that light can store kinetic energy in the electron and be released in the photoelectric effect, consistent with experiments, contrary to the way others have interpreted those experiments. His experiments and data were good. This kind of half-truth is very common among investigators. To reveal a half-truth is still great. Too bad he became a Nazi.

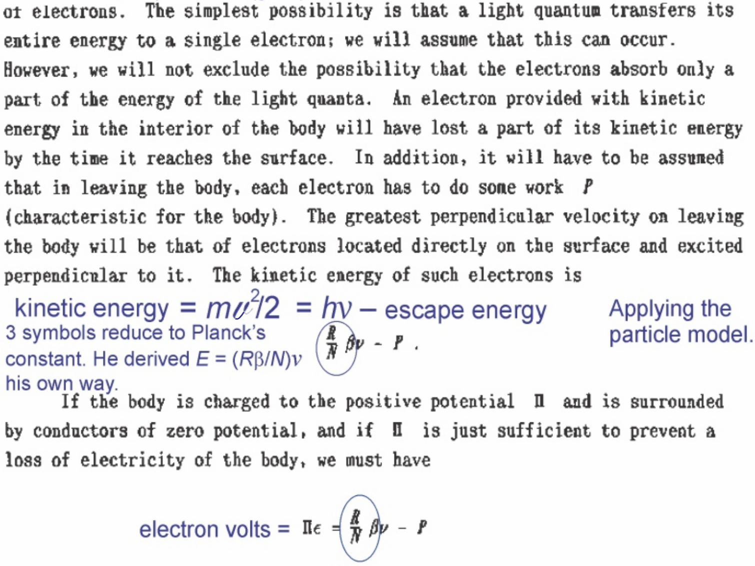
> ...concluded that the energy at escape does not come from the light at all, but from the interior of the particular atom. The light only has an initiating action, rather like that of a of the fuse in firing a loaded gun.
>
> From *On cathode rays Nobel Lecture*, May 28, 1906



The velocity at escape we have already mentioned as very low. I have also found that the velocity is independent of the ultraviolet light intensity (M), and thus concluded that the energy at escape does not come from the light at all, but from the interior of the particular atom. The light only has an initiating action, rather like that of the fuse in firing a loaded gun. I find this conclusion important since from it we learn that not only the atoms of radium - the properties of which were just beginning to be discerned in more detail at that time - contain reserves of energy, but also the atoms of the other elements; these too are capable of emitting radiation and in doing so perhaps completely break down, corresponding to the disintegration and roughening of the substances in ultraviolet light. This view has quite recently been corroborated at the Kiel Institute by special experiments which also showed that the photoelectric effect occurs with unchanged initial velocities even at the temperature of liquid air.

1905. Einstein, *On a Heuristic Point of View About the Creation and Conversion of Light.* Annalen der Physik, 17 (1905) 132. Translated excerpts in black:

According to this picture, the energy of a light wave emitted from a point source is not spread continuously over ever larger volumes, but consists of a finite number of energy quanta that are spatially localized at points of space, move without dividing and are absorbed or generated only as a whole.



Predicts the Compton effect (good).

of electrons. The simplest possibility is that a light quantum transfers its entire energy to a single electron; we will assume that this can occur. However, we will not exclude the possibility that the electrons absorb only a part of the energy of the light quanta. An electron provided with kinetic energy in the interior of the body will have lost a part of its kinetic energy by the time it reaches the surface. In addition, it will have to be assumed that in leaving the body, each electron has to do some work P (characteristic for the body). The greatest perpendicular velocity on leaving the body will be that of electrons located directly on the surface and excited perpendicular to it. The kinetic energy of such electrons is

kinetic energy = $mv^2/2$ = $h\nu$ – escape energy

Applying the particle model.

$$\boxed{\frac{R}{N}}\beta\nu - P \, .$$

3 symbols reduce to Planck's constant. He derived $E = (R\beta/N)\nu$ his own way.

If the body is charged to the positive potential Π and is surrounded by conductors of zero potential, and if Π is just sufficient to prevent a loss of electricity of the body, we must have

$$\text{electron volts} = \Pi\epsilon = \boxed{\frac{R}{N}}\beta\nu - P$$

1910 Lorentz

Die Hypothese der lichtquanten,

P. Zeit. 1910 page 349. His last line:

“Das Gesagte dürfte genügen, um zu zeigen, dass von Lichtquanten, die bei der Fortbewegung in kleinen Räumen konzentriert und stets ungeteüt bleiben, keine Rede sein kann.”

“What has been said should suffice to show that light quanta concentrated in small spaces and always undivided when moving are not to be considered.”

Similar objections and alternative theories to Einstein’s were expressed by Lenard, Planck, JJ Thomson, OW Richardson, Sommerfeld, and Debye (see RH Stuewer).

1911.

Planck. *Theory of Heat Radiation*, Dover book 1959, pg 161.

Planck’s loading theory of 1911 stated continuous absorption and explosive emission. Here energy is thresholded, not quantized.

EMITTED ENERGY. STATIONARY STATE

150. Whereas the absorption of radiation by an oscillator takes place in a perfectly continuous way, so that the energy of the oscillator increases continuously and at a constant rate, for its emission we have, in accordance with Sec. 147, the following law: The oscillator emits in irregular intervals, subject to the laws of chance; it emits, however, only at a moment when its energy of vibration is just equal to an integral multiple n of the elementary quantum $\epsilon = h\nu$, and then it always emits its whole energy of vibration $n\epsilon$.

We may represent the whole process by the following figure in which the abscissæ represent the time t and the ordinates the energy

$$U = n\epsilon + \rho, \quad (\rho < \epsilon) \qquad (251)$$

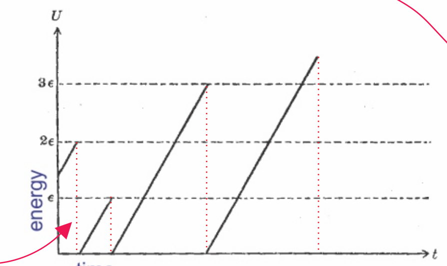


FIG. 7.

Quantization and historical experiments have recognized only those discontinuities.

U = energy, n = Integer,
$\epsilon = h\nu$, ρ = loading term.
$U = nh\nu + \rho$
$\rho < \epsilon, \quad \rho < h\nu, \quad \rho/\nu < h.$
h is a constant expressing a maximum.

This is “Planck’s second theory” and he had it right. Original papers from 1911 and 1912.

1913

Sommerfeld and Debye had a loading theory.
Annalen Der Physik, pg 872, vol 41

Here action at *h*/2π is marked as a threshold of action loading up in their theory of atomic absorption and emission.

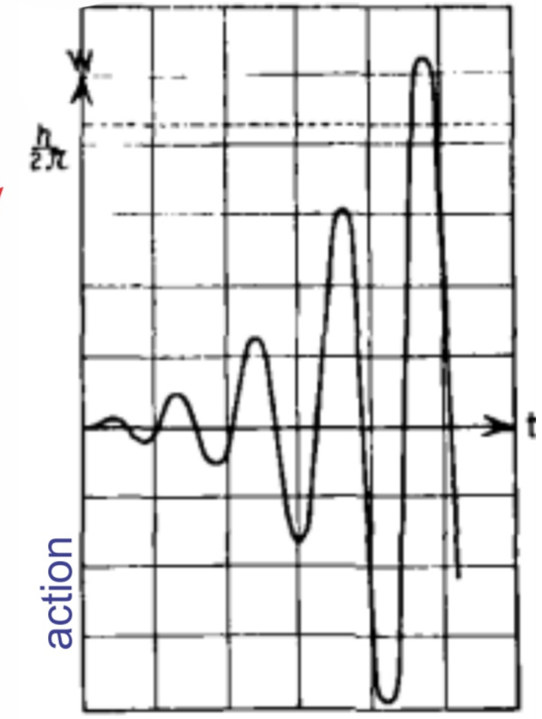


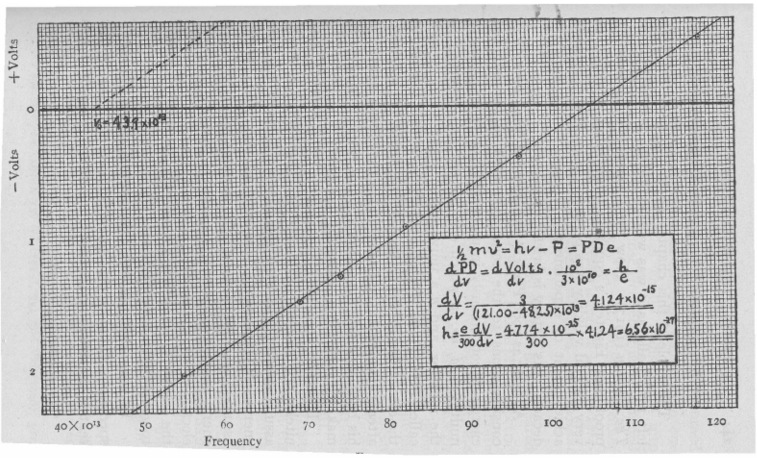
Fig. 1.

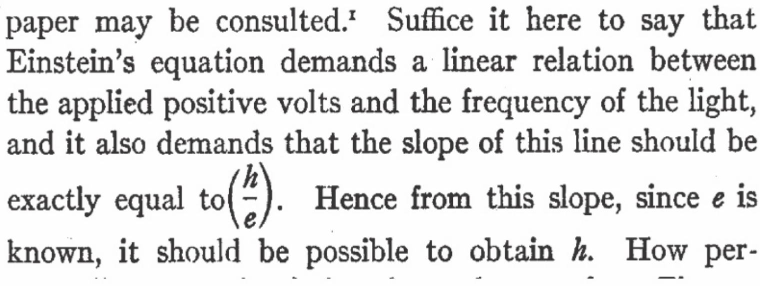
1916. Millikan, R. A. *A Direct Photoelectric Determination of Planck's "h"*. Physical Review, 7 (3). pp. 355-388.

First clear confirmation of linear photoelectric equation of Einstein.

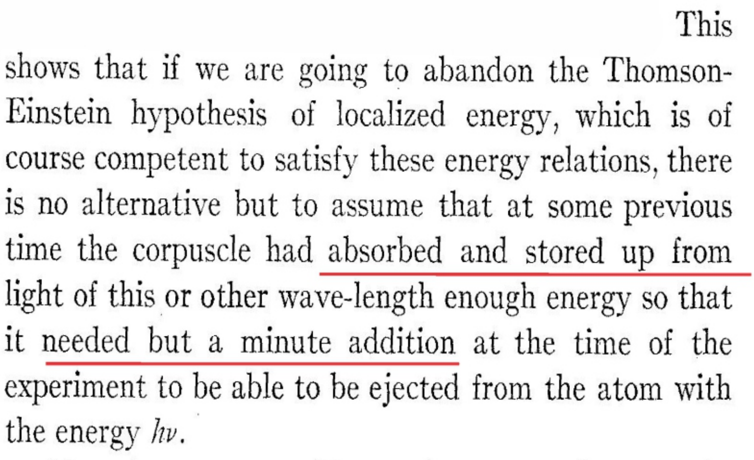
Millikan argued against the photon model.

Experiment determined *h*/*e* ratio, not *h*. Excerpt from *Electrons (+and-)...* page 238.




paper may be consulted.[1] Suffice it here to say that Einstein's equation demands a linear relation between the applied positive volts and the frequency of the light, and it also demands that the slope of this line should be exactly equal to $\left(\frac{h}{e}\right)$. Hence from this slope, since *e* is known, it should be possible to obtain *h*. How per-

1917 Millikan predicts the Unquantum Effect, *The Electron, Its Isolation and Measurement and the Determination of Some of its Properties*. 1917. Page 233

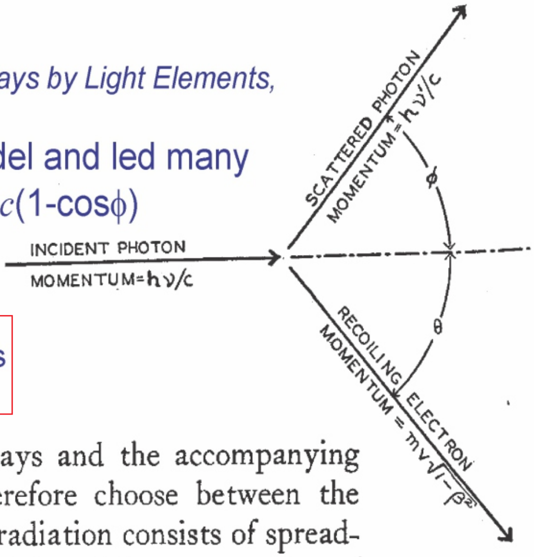


This shows that if we are going to abandon the Thomson-Einstein hypothesis of localized energy, which is of course competent to satisfy these energy relations, there is no alternative but to assume that at some previous time the corpuscle had absorbed and stored up from light of this or other wave-length enough energy so that it needed but a minute addition at the time of the experiment to be able to be ejected from the atom with the energy $h\nu$.

1921 Einstein wins Nobel prize for Photoelectric equation.
The photon model was thought to be correct, but not by Millikan.

1923 Compton,
A Quantum Theory of the Scattering of X-Rays by Light Elements,
Phys Rev V21 #5 page 483 May 1923.

The derivation used the photon model and led many to embrace photons. From $\Delta\lambda = h/mc(1-\cos\phi)$ it measures ***h/m*** ratio.



Assumption: Energy conservation is thought to require particles.

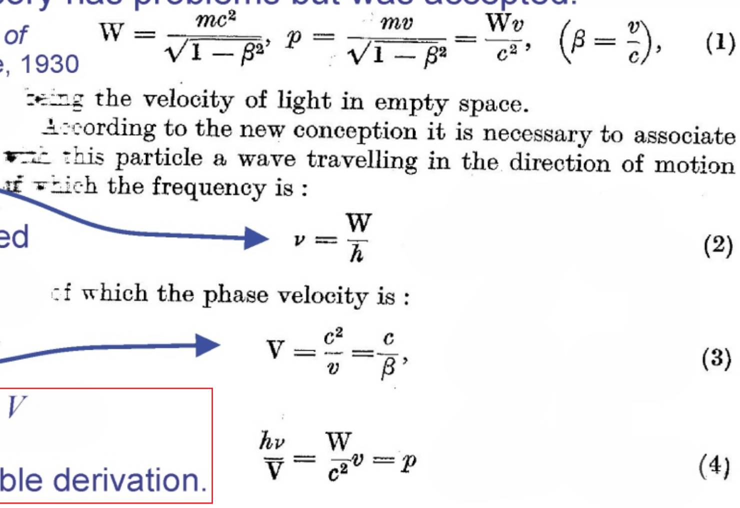
From Compton's later book:

If this work on the scattering of x-rays and the accompanying recoil electrons is correct, we must therefore choose between the familiar hypothesis that electromagnetic radiation consists of spreading waves, on the one hand, and the principles of the conservation of energy and momentum on the other. We cannot retain both.

From *X-Rays in Theory and Experiment*, Compton and Allison.1935, Page 221. The idea was dominant, then and is now. ER says, energy need not be quantized to understand its conservation. Notice in the equation, whole h and whole m are not required. The ratio is quantized.

1924. DeBroglie theory has problems but was accepted.

An Introduction to the Study of Wave Mechanics. deBroglie, 1930



$$W = \frac{mc^2}{\sqrt{1-\beta^2}}, \quad p = \frac{mv}{\sqrt{1-\beta^2}} = \frac{Wv}{c^2}, \quad \left(\beta = \frac{v}{c}\right), \tag{1}$$

being the velocity of light in empty space.

According to the new conception it is necessary to associate with this particle a wave travelling in the direction of motion of which the frequency is :

$$\nu = \frac{W}{h} \tag{2}$$

of which the phase velocity is :

$$V = \frac{c^2}{v} = \frac{c}{\beta}, \tag{3}$$

$$\frac{h\nu}{V} = \frac{W}{c^2}v = p \tag{4}$$

$h\nu = \gamma mc^2$

True for annihilation radiation. Easily misused below that threshold. Requires *delta m*.

$Vv = c^2$

Super c phase velocity V implies probabilitisc ghost wave. Questionable derivation.

$hV/\lambda = \gamma m v V$

$h/\lambda = \gamma m v$

$\lambda = h/\gamma m v$

Those steps can derive deBroglie's famous wave equation. It was used by Schrodinger and fits experiment. However, its derivation implies that λ is of a probability wave.
An alternative derivation by ER removes that problem.

1924. Bohr-Kramers-Slater paper (BKS).

An alternative to the kind of energy quantization proposed by Einstein. BKS had energy conserved in a statistical sense that predicted no coincident *e & x-ray* clicks from Compton scattering.

1924. Bothe-Geiger experiment.

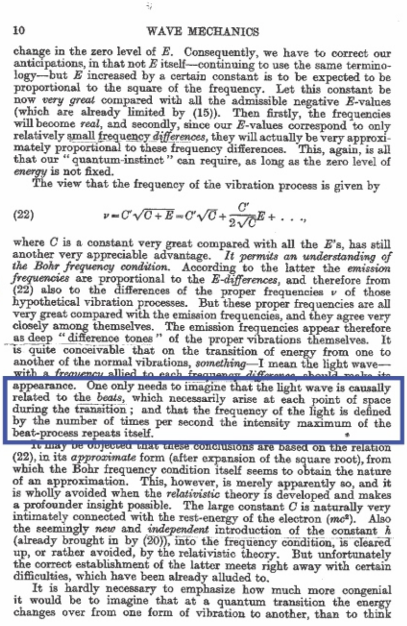
This was the first beam-split coincidence test. It tested timing between *e & x-ray* in Compton scattering. It convinced Bohr to abandon the BKS alternative. Coincident pairs were thought to be evidence of a particle effect, not predicted by BKS. This encouraged accepting QM despite its conceptual difficulty. I call this the "shortest time blunder." It stems from not considering a workable loading theory as explored by Planck, Sommerfeld and Debye.

1926. GP Thomson and Davisson & Germer discover charge diffraction.

This was very great.

1926. Schrödinger,
Collected Papers on Wave Mechanics.

His first famous paper of 1926.



10 WAVE MECHANICS

change in the zero level of E. Consequently, we have to correct our anticipations, in that not E itself—continuing to use the same terminology—but E increased by a certain constant is to be expected to be proportional to the square of the frequency. Let this constant be now *very great* compared with all the admissible negative E-values (which are already limited by (15)). Then firstly, the frequencies will become *real*, and secondly, since our E-values correspond to only relatively small frequency *differences*, they will actually be very approximately proportional to these frequency differences. This, again, is all that our "quantum-instinct" can require, as long as the zero level of *energy* is not fixed.

The view that the frequency of the vibration process is given by

$$\nu = C'\sqrt{C+E} = C'\sqrt{C} + \frac{C'}{2\sqrt{C}}E + \ldots, \tag{22}$$

where C is a constant very great compared with all the E's, has still another very appreciable advantage. *It permits an understanding of the Bohr frequency condition.* According to the latter the *emission frequencies* are proportional to the *E-differences*, and therefore from (22) also to the differences of the proper frequencies ν of those hypothetical vibration processes. But these proper frequencies are all very great compared with the emission frequencies, and they agree very closely among themselves. The emission frequencies appear therefore as deep "difference tones" of the proper vibrations themselves. It is quite conceivable that on the transition of energy from one to another of the normal vibrations, *something*—I mean the light wave—with a *frequency* allied to each frequency *difference*, should make its appearance. One only needs to imagine that the light wave is causally related to the *beats*, which necessarily arise at each point of space during the transition; and that the frequency of the light is defined by the number of times per second the intensity maximum of the beat-process repeats itself.

It may be objected that these conclusions are based on the relation (22), in its *approximate* form (after expansion of the square root), from which the Bohr frequency condition itself seems to obtain the nature of an approximation. This, however, is merely apparently so, and it is wholly avoided when the *relativistic* theory is developed and makes a profounder insight possible. The large constant C is naturally very intimately connected with the rest-energy of the electron (mc^2). Also the seemingly *new* and *independent* introduction of the constant h (already brought in by (20)), into the frequency condition, is cleared up, or rather avoided, by the relativistic theory. But unfortunately the correct establishment of the latter meets right away with certain difficulties, which have been already alluded to.

It is hardly necessary to emphasize how much more congenial it would be to imagine that at a quantum transition the energy changes over from one form of vibration to another, than to think

He understood that light interacts with beats of his Ψ-wave.

Threshold model of ER expands on this idea.
Charge is the envelope of Ψ.

appearance. One only needs to imagine that the light wave is causally related to the *beats*, which necessarily arise at each point of space during the transition; and that the frequency of the light is defined by the number of times per second the intensity maximum of the beat-process repeats itself.

Schrödinger hated quantum mechanics.

His original wave function was about a charge density.
Max Born changed it to a probability density.
From *The Interpretation of Quantum Mechanics, Dublin Lectures* book 1995.

JULY 1952 COLLOQUIUM

1 • Introduction

Let me say at the outset, that in this discourse, I am opposing not a few special statements of quantum mechanics held today, I am opposing as it were the whole of it, I am opposing its basic views that have been shaped 25 years ago, when Max Born put forward his probability interpretation, which was accepted by almost everybody. It has been worked out in great detail to form a scheme of admirable logical consistency that has been inculcated ever since to every young student of theoretical physics.

1928 *The Element of Time in the Photoelectric Effect* Lawrence and Beams, Physical Review 32, 482.

3 ns was their shortest response time, not total time. Textbooks quote only this 3 ns, giving the student the illusion that 3 ns is the total response time.

The experiment was good but falsely represented. They are taught to not consider a pre-loaded state.

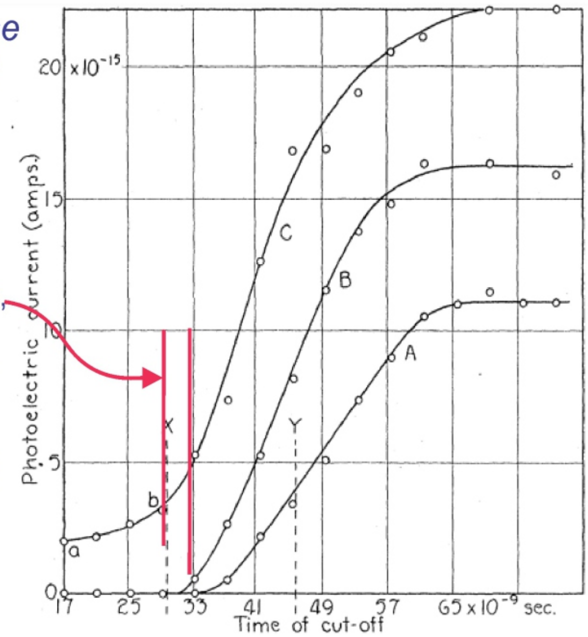
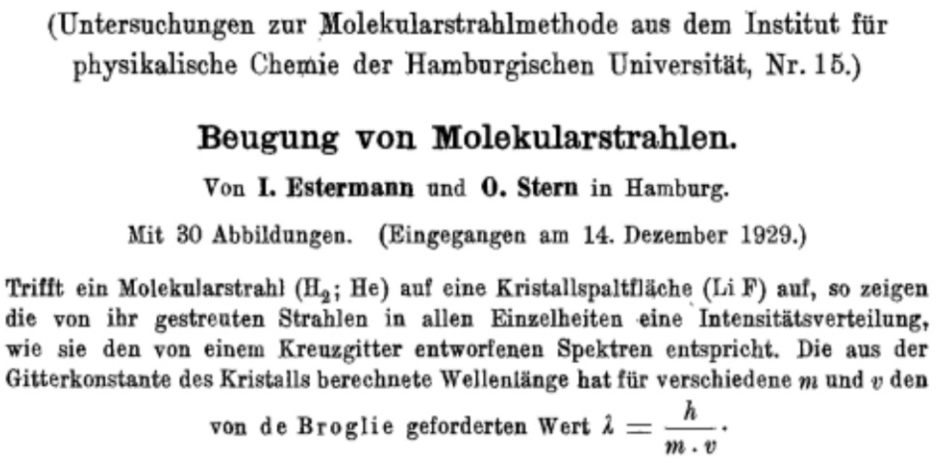


Fig. 4. Photoelectric currents to the collector for various times of cut-off af ginning of the spark.

1929 Estermann and Stern. *Diffraction of Molecular Rays.* Helium atoms diffracted by the de Broglie equation. This is very great. It should be obvious that if helium was always in a particle state, it should not exhibit diffraction. Instead, physics embraced a particle atom and a spooky probability-wave. In my analysis, this happened from thinking of energy conservation, only in detectable particle units. They deny the possibility of a physical matter wave.



(Untersuchungen zur Molekularstrahlmethode aus dem Institut für physikalische Chemie der Hamburgischen Universität, Nr. 15.)

Beugung von Molekularstrahlen.

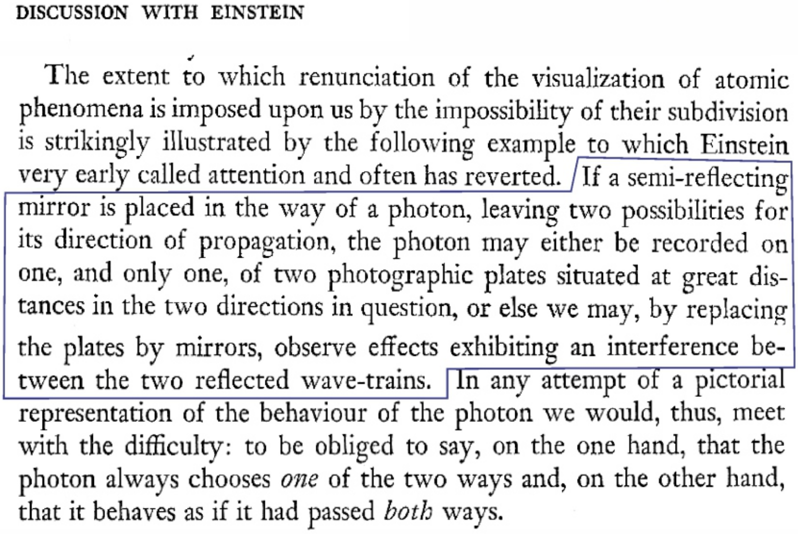
Von **I. Estermann** und **O. Stern** in Hamburg.

Mit 30 Abbildungen. (Eingegangen am 14. Dezember 1929.)

Trifft ein Molekularstrahl (H_2; He) auf eine Kristallspaltfläche (Li F) auf, so zeigen die von ihr gestreuten Strahlen in allen Einzelheiten eine Intensitätsverteilung, wie sie den von einem Kreuzgitter entworfenen Spektren entspricht. Die aus der Gitterkonstante des Kristalls berechnete Wellenlänge hat für verschiedene m und v den von de Broglie geforderten Wert $\lambda = \frac{h}{m \cdot v}$.

Photon Definition

Bohr, *Atomic Physics and Human Knowledge*. 1958



DISCUSSION WITH EINSTEIN

The extent to which renunciation of the visualization of atomic phenomena is imposed upon us by the impossibility of their subdivision is strikingly illustrated by the following example to which Einstein very early called attention and often has reverted. If a semi-reflecting mirror is placed in the way of a photon, leaving two possibilities for its direction of propagation, the photon may either be recorded on one, and only one, of two photographic plates situated at great distances in the two directions in question, or else we may, by replacing the plates by mirrors, observe effects exhibiting an interference between the two reflected wave-trains. In any attempt of a pictorial representation of the behaviour of the photon we would, thus, meet with the difficulty: to be obliged to say, on the one hand, that the photon always chooses *one* of the two ways and, on the other hand, that it behaves as if it had passed *both* ways.

to paraphrase:

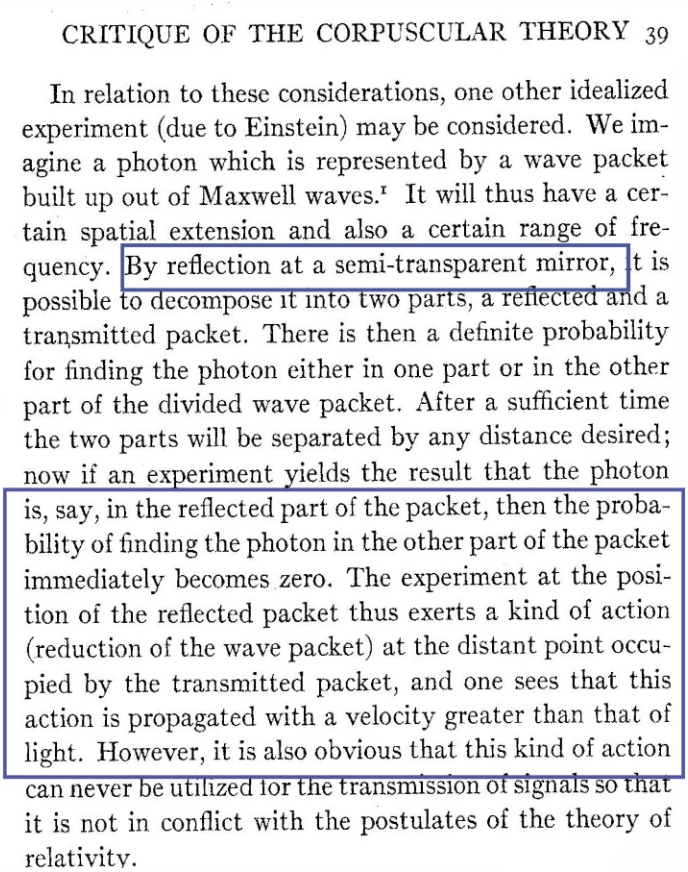
A photon goes one way or another at a beam-splitter, but must also go both ways to display interference.

This is a combination of Phenomena; not visualizable.

1930. Heisenberg, *Quantum Theory*.

Here Heisenberg describes Einstein's photon and wave-function collapse.

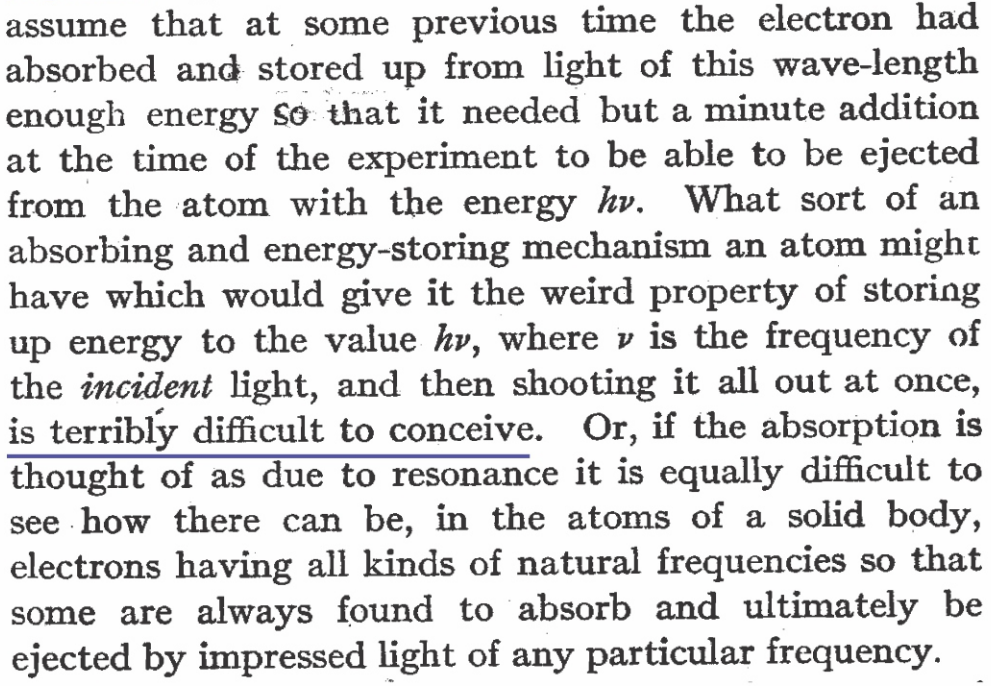
This model was accepted long before it was directly tested, and is thought to accurately describe nature to this day.



CRITIQUE OF THE CORPUSCULAR THEORY 39

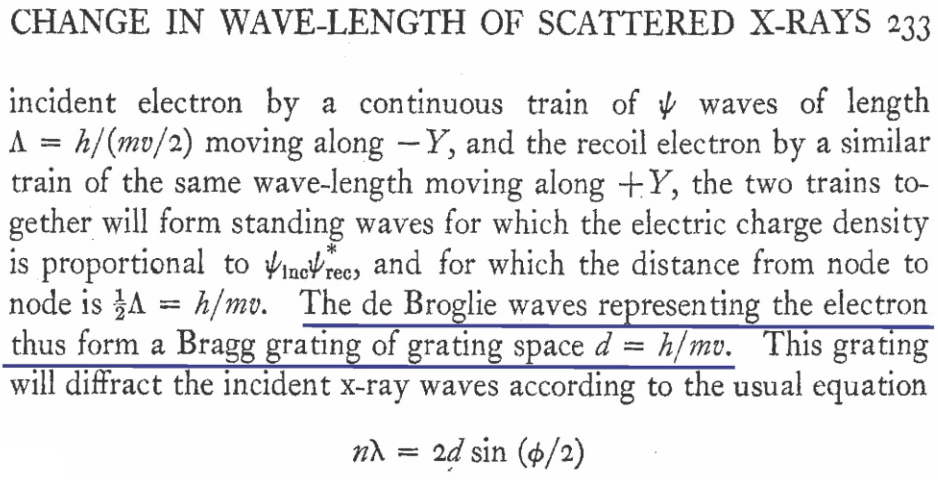
In relation to these considerations, one other idealized experiment (due to Einstein) may be considered. We imagine a photon which is represented by a wave packet built up out of Maxwell waves.[1] It will thus have a certain spatial extension and also a certain range of frequency. By reflection at a semi-transparent mirror, it is possible to decompose it into two parts, a reflected and a transmitted packet. There is then a definite probability for finding the photon either in one part or in the other part of the divided wave packet. After a sufficient time the two parts will be separated by any distance desired; now if an experiment yields the result that the photon is, say, in the reflected part of the packet, then the probability of finding the photon in the other part of the packet immediately becomes zero. The experiment at the position of the reflected packet thus exerts a kind of action (reduction of the wave packet) at the distant point occupied by the transmitted packet, and one sees that this action is propagated with a velocity greater than that of light. However, it is also obvious that this kind of action can never be utilized for the transmission of signals so that it is not in conflict with the postulates of the theory of relativity.

1935 Millikan abandons the loading theory. This is the last mention I could find of a loading theory that acknowledged the idea of a pre-loaded state. After this book, all accounts of a loading or accumulation hypothesis will acknowledge only the shortest measurable accumulation time. *Electrons (+and-)...*, 1947 page 235.



assume that at some previous time the electron had absorbed and stored up from light of this wave-length enough energy so that it needed but a minute addition at the time of the experiment to be able to be ejected from the atom with the energy $h\nu$. What sort of an absorbing and energy-storing mechanism an atom might have which would give it the weird property of storing up energy to the value $h\nu$, where ν is the frequency of the *incident* light, and then shooting it all out at once, is terribly difficult to conceive. Or, if the absorption is thought of as due to resonance it is equally difficult to see how there can be, in the atoms of a solid body, electrons having all kinds of natural frequencies so that some are always found to absorb and ultimately be ejected by impressed light of any particular frequency.

1935 Compton and Allison, *X-Rays in Theory and Experiment.* Wave derivation of the Compton effect using Bragg scattering and Doppler effect. Photons are not necessary.



CHANGE IN WAVE-LENGTH OF SCATTERED X-RAYS 233

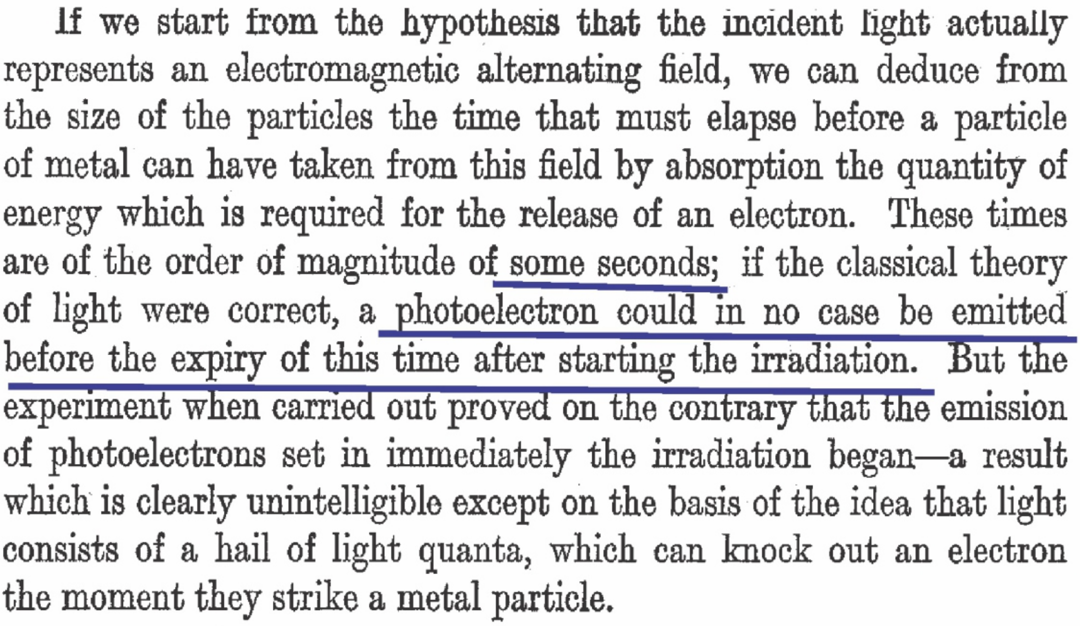
incident electron by a continuous train of ψ waves of length $\Lambda = h/(mv/2)$ moving along $-Y$, and the recoil electron by a similar train of the same wave-length moving along $+Y$, the two trains together will form standing waves for which the electric charge density is proportional to $\psi_{\mathrm{inc}}\psi^*_{\mathrm{rec}}$, and for which the distance from node to node is $\frac{1}{2}\Lambda = h/mv$. The de Broglie waves representing the electron thus form a Bragg grating of grating space $d = h/mv$. This grating will diffract the incident x-ray waves according to the usual equation

$$n\lambda = 2d\sin(\phi/2)$$

1935 EPR.

Einstein Pedolsoky and Rosen challenge quantum mechanics.

1935, Max Born, Shortest time blunder in the photoelectric effect. *Atomic Physics*, Max Born, 5th edition, 1951, pg 82.



If we start from the hypothesis that the incident light actually represents an electromagnetic alternating field, we can deduce from the size of the particles the time that must elapse before a particle of metal can have taken from this field by absorption the quantity of energy which is required for the release of an electron. These times are of the order of magnitude of some seconds; if the classical theory of light were correct, a photoelectron could in no case be emitted before the expiry of this time after starting the irradiation. But the experiment when carried out proved on the contrary that the emission of photoelectrons set in immediately the irradiation began—a result which is clearly unintelligible except on the basis of the idea that light consists of a hail of light quanta, which can knock out an electron the moment they strike a metal particle.

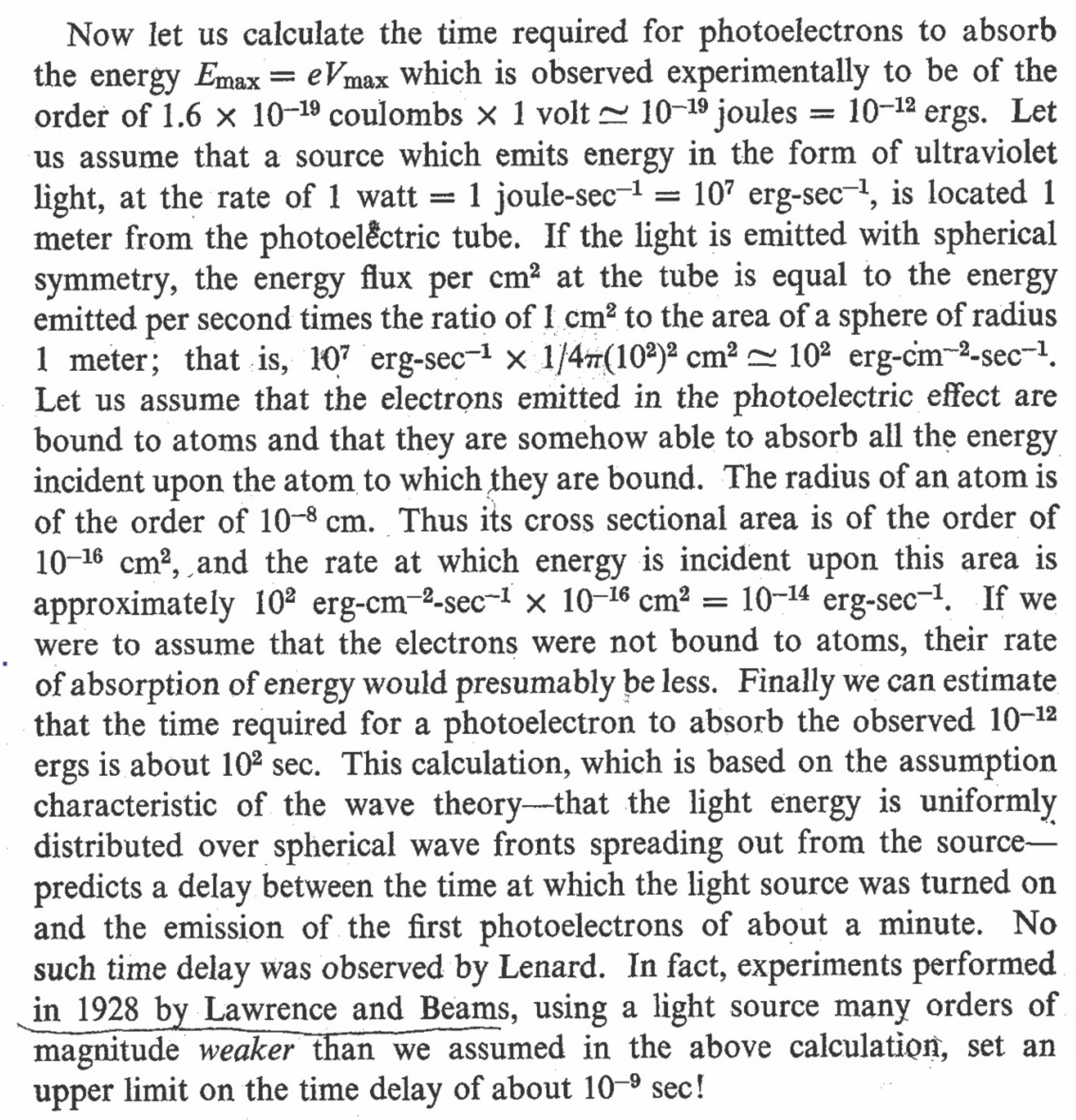
1956 Bernstein and Mann, in a review on repeats of the Compton effect, only looked for the shortest coincidence times, thereby eliminating any thought of semi classical alternatives.

1964 Bell proposes of test of EPR challenge.

1961 Eisberg, Fundamentals of Modern Physics, seventh printing 1967 page 79.

This error was repeated in textbooks by Resnick, Eisberg and Resnick, Halliday and Resnick, Tipler, Weidner and Sells and I expect others. It effectively brainwashed generations of students to think that the loading theory was wrong.

Also in these and other books, they derive Planck's black body equation using standing waves of light. There are may ways to derive the equation using oscillators in the walls of the cavity.



Now let us calculate the time required for photoelectrons to absorb the energy $E_{\max} = eV_{\max}$ which is observed experimentally to be of the order of 1.6×10^{-19} coulombs $\times$ 1 volt $\simeq 10^{-19}$ joules $= 10^{-12}$ ergs. Let us assume that a source which emits energy in the form of ultraviolet light, at the rate of 1 watt $=$ 1 joule-sec^{-1} $= 10^7$ erg-sec^{-1}, is located 1 meter from the photoelectric tube. If the light is emitted with spherical symmetry, the energy flux per cm^2 at the tube is equal to the energy emitted per second times the ratio of 1 cm^2 to the area of a sphere of radius 1 meter; that is, 10^7 erg-sec^{-1} $\times 1/4\pi(10^2)^2$ cm^2 $\simeq 10^2$ erg-cm^{-2}-sec^{-1}. Let us assume that the electrons emitted in the photoelectric effect are bound to atoms and that they are somehow able to absorb all the energy incident upon the atom to which they are bound. The radius of an atom is of the order of 10^{-8} cm. Thus its cross sectional area is of the order of 10^{-16} cm^2, and the rate at which energy is incident upon this area is approximately 10^2 erg-cm^{-2}-sec^{-1} $\times 10^{-16}$ cm^2 $= 10^{-14}$ erg-sec^{-1}. If we were to assume that the electrons were not bound to atoms, their rate of absorption of energy would presumably be less. Finally we can estimate that the time required for a photoelectron to absorb the observed 10^{-12} ergs is about 10^2 sec. This calculation, which is based on the assumption characteristic of the wave theory—that the light energy is uniformly distributed over spherical wave fronts spreading out from the source—predicts a delay between the time at which the light source was turned on and the emission of the first photoelectrons of about a minute. No such time delay was observed by Lenard. In fact, experiments performed in 1928 by Lawrence and Beams, using a light source many orders of magnitude *weaker* than we assumed in the above calculation, set an upper limit on the time delay of about 10^{-9} sec!

1974 Clauser. Particle component of photon model tested.

PHYSICAL REVIEW D VOLUME 9, NUMBER 4 15 FEBRUARY 1974

Experimental distinction between the quantum and classical field-theoretic predictions for the photoelectric effect*

John F. Clauser

Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720

(Received 30 October 1973)

We have measured various coincidence rates between four photomultiplier tubes viewing cascade photons on opposite sides of dielectric beam splitters. This experimental configuration, we show, is sensitive to differences between the classical and quantum field-theoretic predictions for the photoelectric effect. The results, to a high degree of statistical accuracy, contradict the predictions by any classical or semiclassical theory in which the probability of photoemission is proportional to the classical intensity.

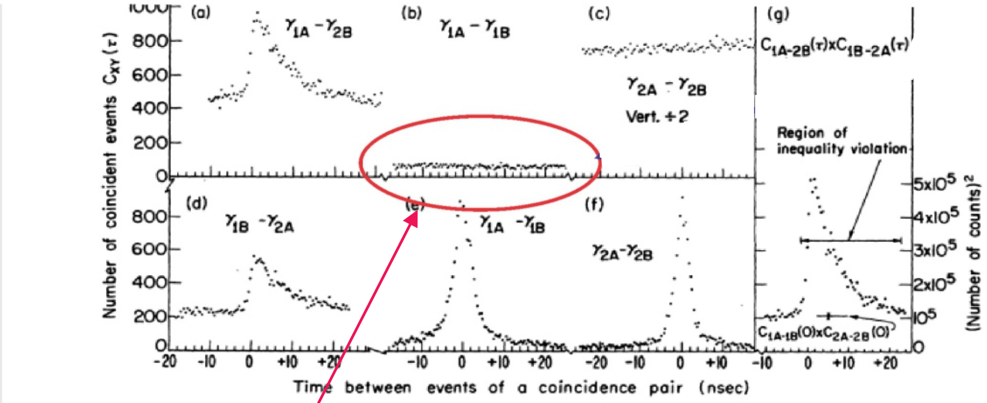


FIG. 3. (a)–(d) Time-delay coincidence spectra of the four monitored channels: C_{1A-2B}, C_{1A-1B}, C_{2A-2B}, and C_{1B-2A}. (e)–(f) C_{1A-1B} and C_{2A-2B} coincidence spectra in response to short pulses of light incident upon beam splitters produced by a barium titanate source. (g) Product of C_{1A-2B} and C_{1B-2A} versus time delay. For small times this clearly exceeds the indicated value of the product C_{2A-2B} and C_{1A-1B} evaluated at zero delay.

Any peak here says that the time within click-pairs exceeds accidental chance. QM predicts chance. Therefore they will say that QM is upheld. This and similar tests suffer from using visible light, which is not able to distinguish quantized from non-quantized energy conservation.

The other plots are control tests using sources of known coincident pairs.

PHYSICAL REVIEW LETTERS 17 August 1981

Experimental Tests of Realistic Local Theories via Bell's Theorem

Alain Aspect, Philippe Grangier, and Gérard Roger

1981. It is confusing. In this case, experimental data, classical theory of Malus, and QM all agree. QM usually works and in this case its result is reasonable. However, Bell's theory predicts straight lines instead of the sine curve from this experiment (and classical and QM). This convinces many that nature is weird by agreeing with QM, which is weird. Nature need not be weird because in this case QM and classical agree the way it should. The theoretical background Bell applied to this EPR test-idea has caused endless confusion to this day.

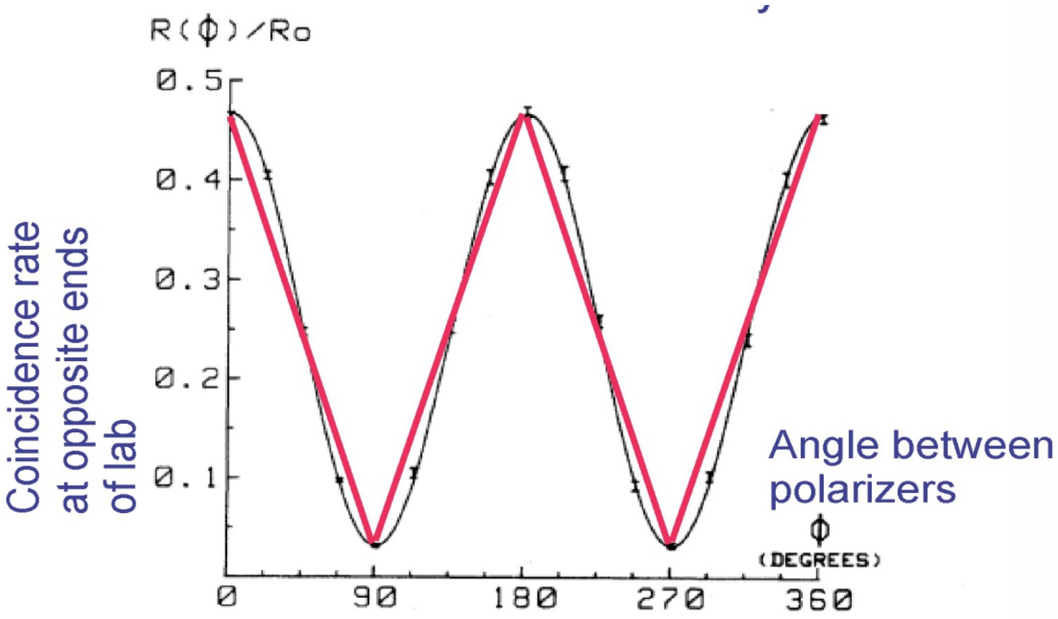


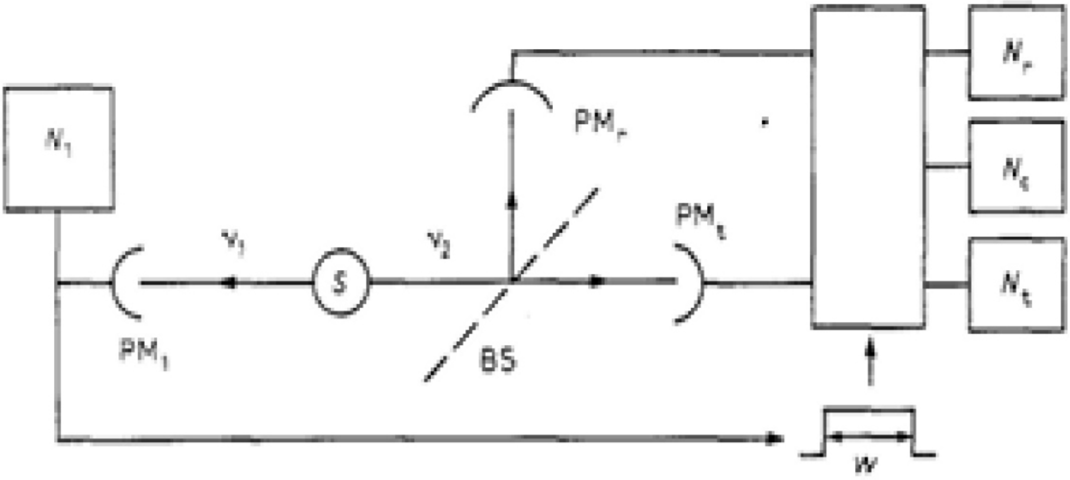
FIG. 4. Normalized coincidence rate as a function of the relative polarizer orientation. Indicated errors are ± 1 standard deviation. The solid curve is not a fit to the data but the prediction of quantum mechanics.

1985 Aspect. Test of wave and particle properties.

Experimental Evidence for a Photon Anticorrelation Effect on a Beam Splitter: A New Light on Single-Photon Interferences.

P. GRANGIER, G. ROGER and A. ASPECT (*)
Institut d'Optique Théorique et Appliquée, B.P. 43 - F 91406 *Orsay, France*

(received 11 November 1985; accepted in final form 20 December 1985)



Objections by ER: Beam splitters are polarizing. To only see chance is really just seeing noise. Detectors have dead time. Detectors have inadequate pulse-height resolution.

1985 QED, The Strange Theory of Light and Matter by R P Feynmann, Pinceton University Press, page 15.

Eric says:

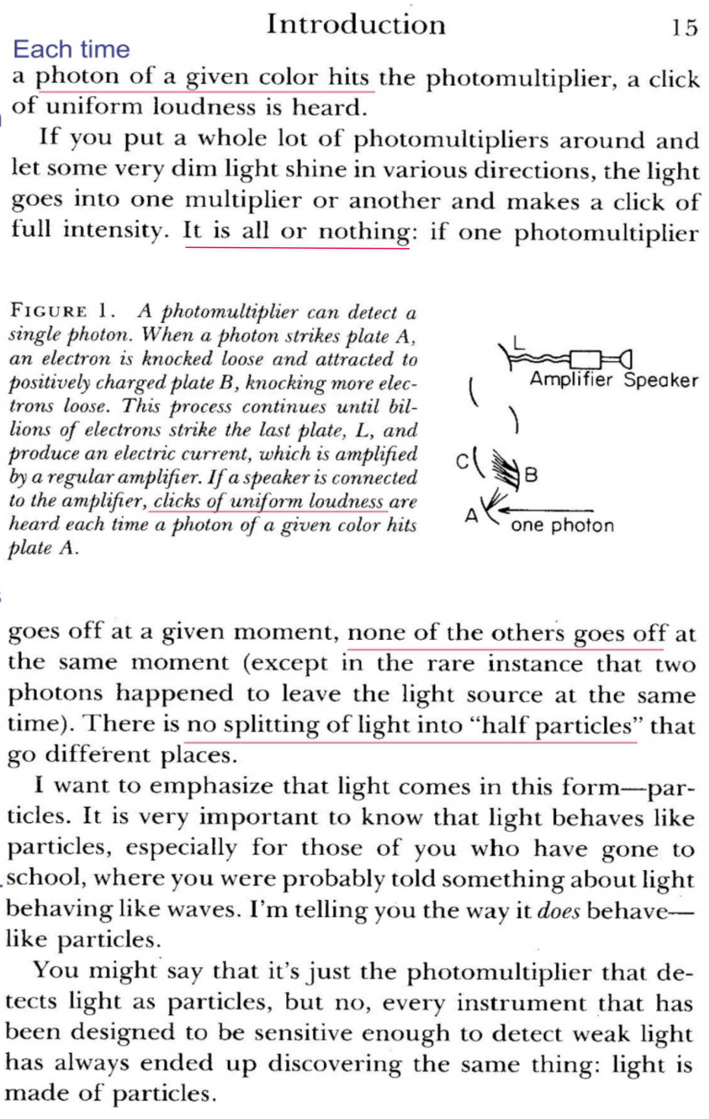
If you explain in terms of photons, you will end with photons.

Clicks are not of uniform loudness.
The next page shows the wide distribution for monochromatic light.

It only seems like "all or nothing" because visible light tests will read time in a noisy way, and quantum mechanics predicts that noisy way.

Splitting does happen in the Compton effect with lowed frequencies.
Lower frequency is like half particles, in quantum-speak.

All detectors make those clicks, but that does not mean light is made of particles.



Introduction 15

Each time a photon of a given color hits the photomultiplier, a click of uniform loudness is heard.

If you put a whole lot of photomultipliers around and let some very dim light shine in various directions, the light goes into one multiplier or another and makes a click of full intensity. It is all or nothing: if one photomultiplier goes off at a given moment, none of the others goes off at the same moment (except in the rare instance that two photons happened to leave the light source at the same time). There is no splitting of light into "half particles" that go different places.

I want to emphasize that light comes in this form—particles. It is very important to know that light behaves like particles, especially for those of you who have gone to school, where you were probably told something about light behaving like waves. I'm telling you the way it *does* behave—like particles.

You might say that it's just the photomultiplier that detects light as particles, but no, every instrument that has been designed to be sensitive enough to detect weak light has always ended up discovering the same thing: light is made of particles.

FIGURE 1. *A photomultiplier can detect a single photon. When a photon strikes plate A, an electron is knocked loose and attracted to positively charged plate B, knocking more electrons loose. This process continues until billions of electrons strike the last plate, L, and produce an electric current, which is amplified by a regular amplifier. If a speaker is connected to the amplifier, clicks of uniform loudness are heard each time a photon of a given color hits plate A.*

They think this way because they think energy must be quantized.
The trouble with quantum mechanics is the quantum.

1999

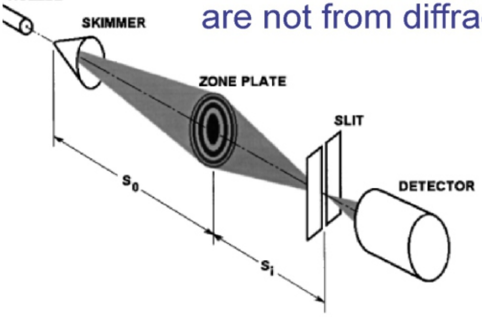
Doak

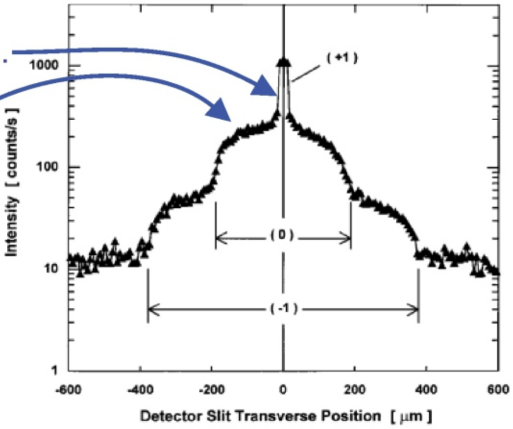
PHYSICAL REVIEW LETTERS 22 NOVEMBER 1999

**Towards Realization of an Atomic de Broglie Microscope:
Helium Atom Focusing Using Fresnel Zone Plates**

Effect of focused helium waves cannot happen by true particles.

True particles landing here are not from diffraction.





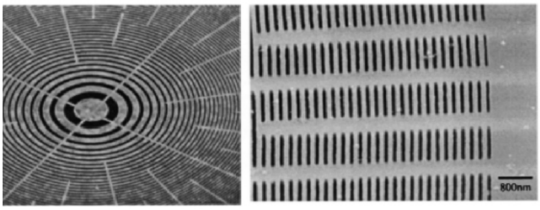
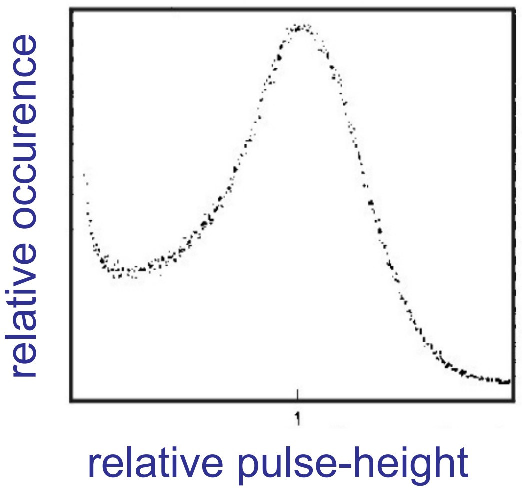


FIG. 2. Transverse scan of detector slit in steps of 6.9 μ through the focused He atom beam. The nozzle temperatu was $T_0 = 124$ K to yield a de Broglie wavelength λ 0.88 Å, giving a zone plate focal length of 307 mm. Und these conditions the 4 μm diameter beam skimmer should b optimally focused onto the 25 μm detector slit. The centr peak is due to the focused (+1) diffraction channel. Underlyin plateaus corresponding to the undiffracted (0) channel an defocused (−1) channel are identified on the basis of th expected widths of these features, as marked.

For matter, this is the first clear display of both wave and particle effects in the same experiment.

Photomultiplier pulse-height for monochromatic light



Typical "single electron spectrum." Resolution 67% FWHM. Peak to valley ratio 2.8:1. From *Photomultiplier tubes principles and applications*, Philips Photonics, pg 2-8 (1994).

Pulse-height filters are always used in these tests.
The range of pulse-heights for any visible light detector is too wide to make the distinction between quantum or loading theory.

If the gate is too low, small pulses can cause pulse-pairs that favor loading.

If the gate is high, it eliminates pulses that would favor a loading.

Papers that test the photon never* say how they set the gate.

*in all my search.

In conclusion, we pose these questions.

Is charge in free space quantized?

Does energy conservation require quantized particles?

If an equation fits an experiment, are the assumptions valid?

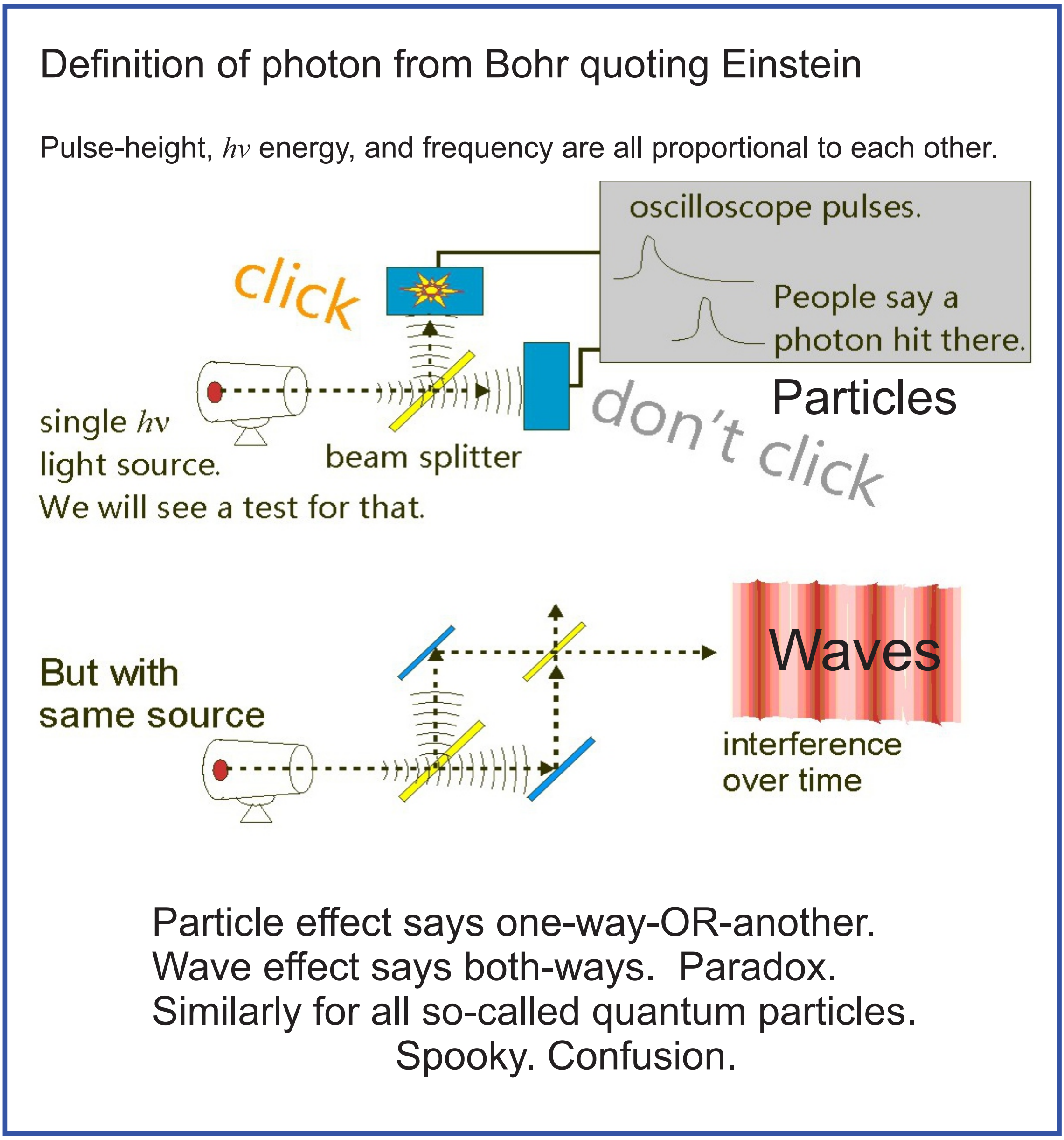
Does a short response time force quantization?
Did experimentalists ignore longer response times to favor QM?

In the beam-split coincident test, does absence of coincident clicks confirm QM?

Do visible light detectors have adequate time and energy resolution to distinguish between QM and a loading theory?

Lecture slides

Experiment and Theory Removing Wave-Particle Duality



Definition of photon from Bohr quoting Einstein

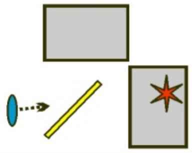
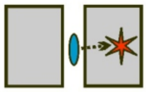
Pulse-height, $h\nu$ energy, and frequency are all proportional to each other.

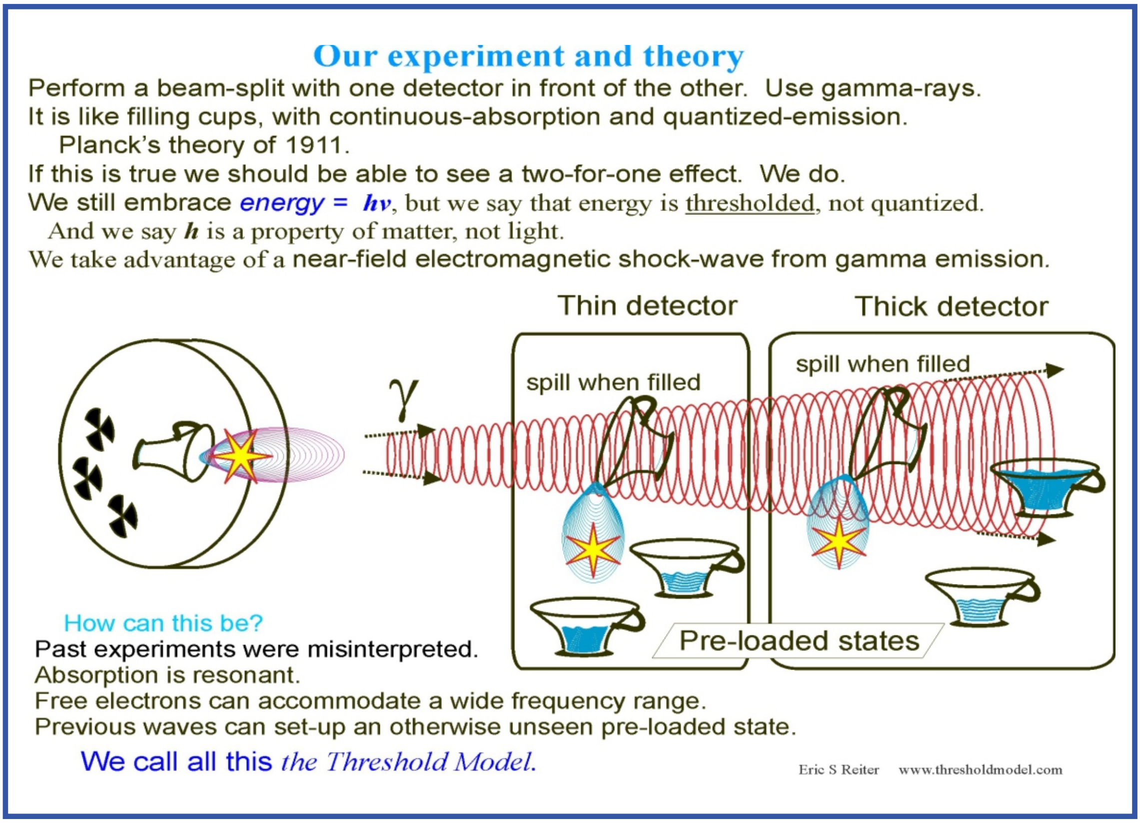
Particle effect says one-way-OR-another.
Wave effect says both-ways. Paradox.
Similarly for all so-called quantum particles.
Spooky. Confusion.

Definitions

Models	electromagnetic, light	matter, rest mass
classical wave: interference, spreads	light waves	water, sound
classical particle: holds together		planet, large molecule
QM particle: wave-particle duality	probability calculation "photon" clicks	probability calculation electron, proton, atom, etc.
Threshold model: Add wave properties. Accumulation hypothesis, Loading theory.	classical light waves clicks	two-states soliton charge matter-wave Clicks.

Preview of coincidence tests

	light	gamma	alpha	other stuff
 Beam-split geometry	others QM	ER UNQ	ER UNQ	
 Tandem geometry does the same thing.		ER UNQ		QM
 One-at-a-time test.		ER & others QM	ER & others QM	others QM



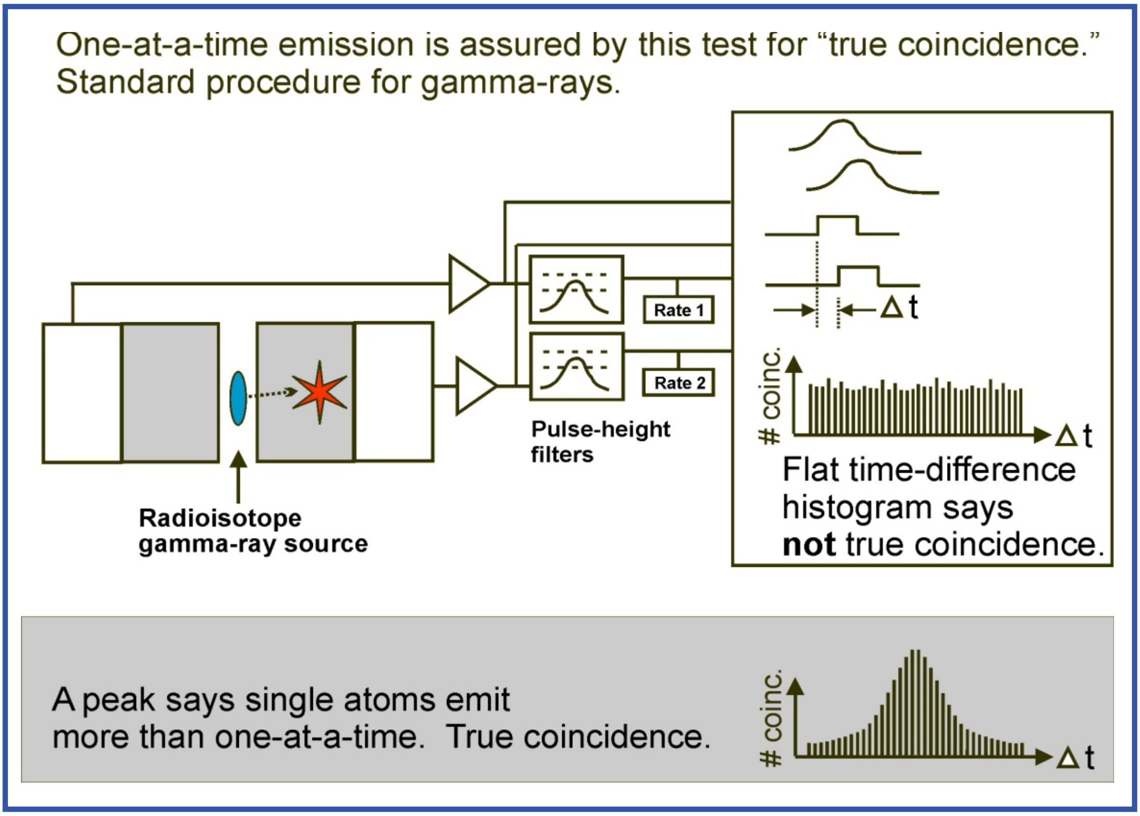
Our experiment and theory

Perform a beam-split with one detector in front of the other. Use gamma-rays.
It is like filling cups, with continuous-absorption and quantized-emission.
Planck's theory of 1911.
If this is true we should be able to see a two-for-one effect. We do.
We still embrace *energy* = ***hv***, but we say that energy is thresholded, not quantized.
And we say ***h*** is a property of matter, not light.
We take advantage of a near-field electromagnetic shock-wave from gamma emission.

How can this be?
Past experiments were misinterpreted.
Absorption is resonant.
Free electrons can accommodate a wide frequency range.
Previous waves can set-up an otherwise unseen pre-loaded state.

We call all this *the Threshold Model.*

Eric S Reiter www.thresholdmodel.com



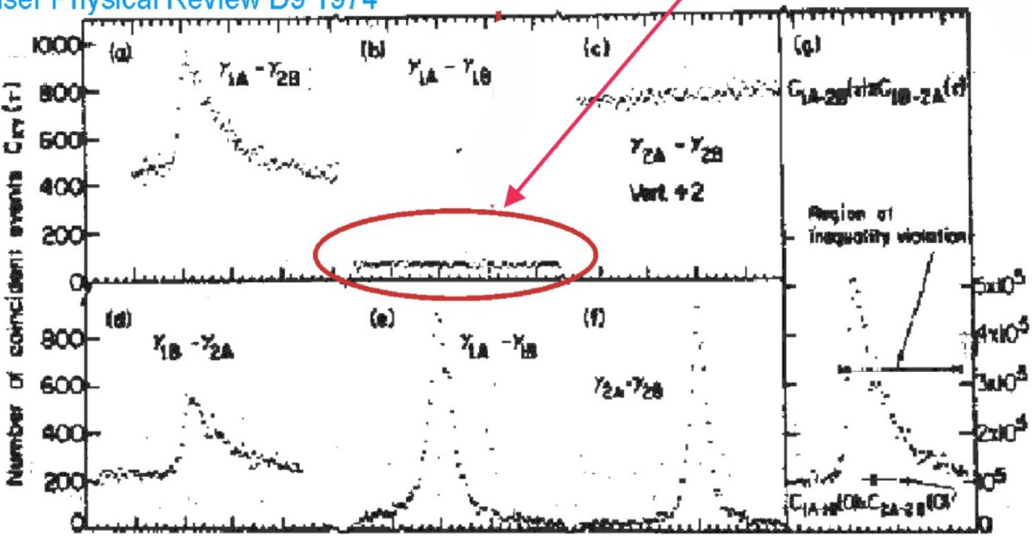
One-at-a-time emission is assured by this test for "true coincidence."
Standard procedure for gamma-rays.

Flat time-difference histogram says **not** true coincidence.

A peak says single atoms emit more than one-at-a-time. True coincidence.

Now consider beam-split orientation.
Similar previous tests using visible light gave *chance* in this same kind of Δt histogram.

Clauser Physical Review D9 1974

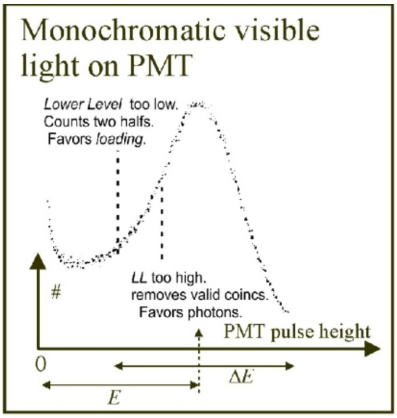


Pulse-height histograms

Visible light detectors cannot faithfully represent $h\nu$ energy in pulse-height.

QM authors never report these pulse filter settings.

$\Delta E > E$

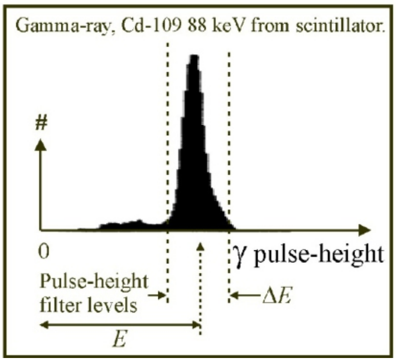


Monochromatic visible light on PMT

Pulse heights from gamma detectors are closer to being proportional to frequency.
Here a reasonable test can be made between quantum mechanics and a loading theory.

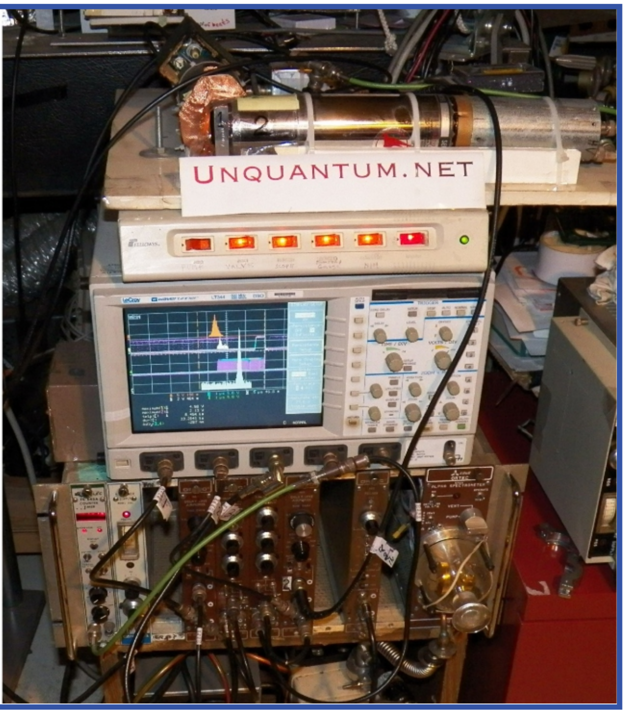
(pulse height) ∝ (frequency) ∝ (***hν*** energy)

$\Delta E < E$

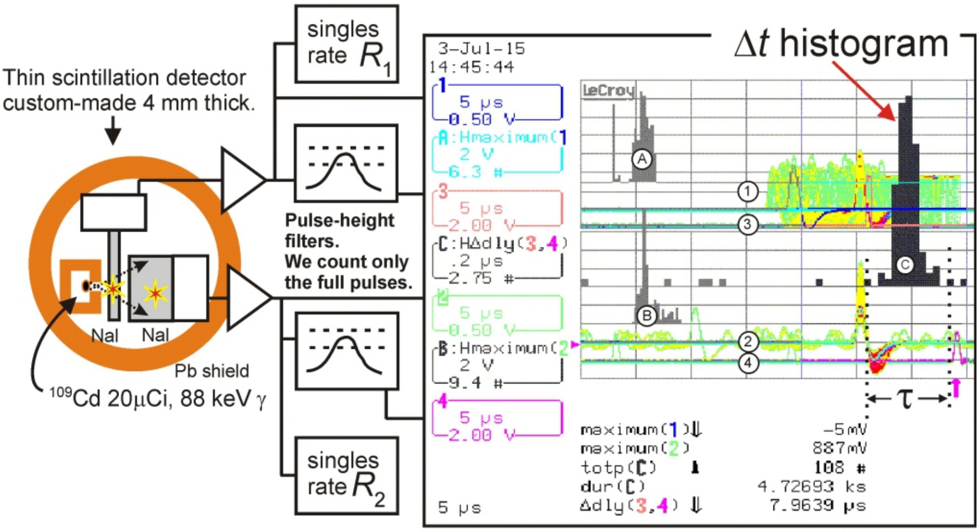


Gamma-ray, Cd-109 88 keV from scintillator.

Unquantum Effect Demonstrator



Gamma-ray beam-split coincidence experiment



```
3-Jul-15
14:45:44
1
 5 µs
0.50 V
A:Hmaximum(1
 2 V
6.3 #
3
 5 µs
2.00 V
C:HΔdly(3,4)
 .2 µs
2.75 #
2
 5 µs
0.50 V
B:Hmaximum(2
 2 V
9.4 #
4
 5 µs
2.00 V
5 µs
maximum(1)⇓          -5mV
maximum(2)          887mV
totp(C)             108 #
dur(C)         4.72693 ks
Δdly(3,4) ⇓    7.9639 µs
```

Experimental coinc rate within 300ns R'_e=106/4.727ks = 0.0224/s

Background coinc rate with removed source = 0.00615/s

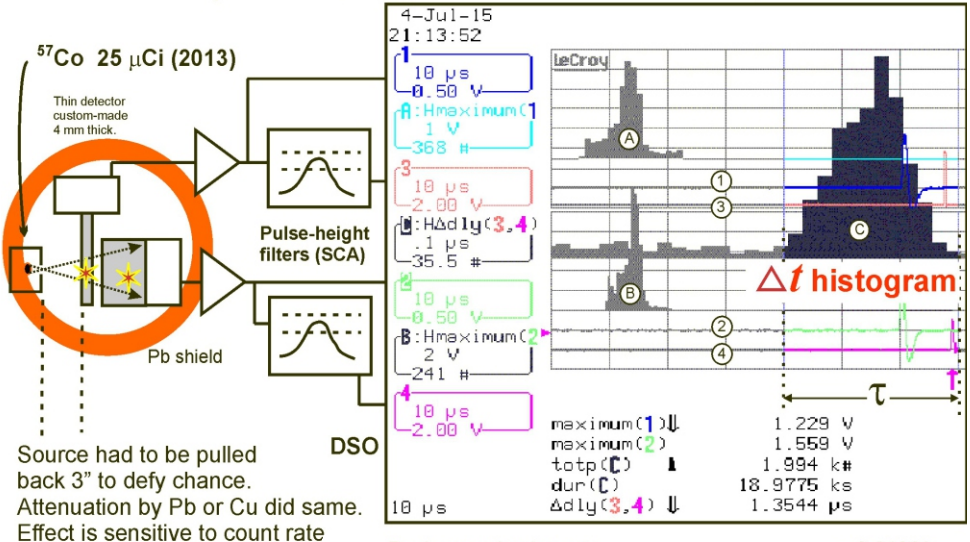
Corrected R_e= 0.0224/s – 0.00615/s = 0.0163/s

Chance rate $R_c=R_1R_2\tau$=(269/s)(8.2/s)(300ns)=0.000662/s

R_e/R_c = 24.6 times chance. **This is the unquantum effect.**

Gamma-ray tandem beam-split test with 122 keV from Co-57

Two γ are within our energy window from different atoms. Decays to stable Fe-57.



```
maximum(1)⇓        1.229 V
maximum(2)         1.559 V
totp(C)            1.994 k#
dur(C)           18.9775 ks
Δdly(3,4) ⇓       1.3544 μs
```

Source had to be pulled back 3” to defy chance.
Attenuation by Pb or Cu did same.
Effect is sensitive to count rate

and distance.

Background coinc rate = 0.0139/s

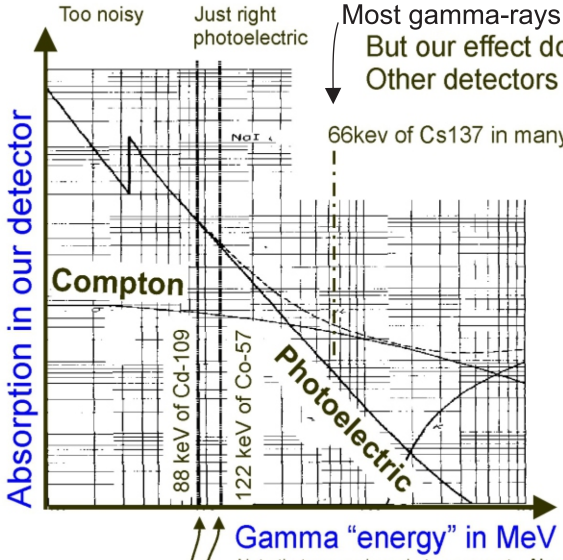
Experimental coinc rate = R_e=1994/18977s = 0.105/s

Corrected R_e= 0.105/s – 0.0142/s = 0.0907/s

Chance rate =R_c=$R_1R_2\tau$=(616/s)(82.9/s)(300ns) =0.0153/s

R_e/R_c = 5.93 times chance.

Our unquantum effect works where the photoelectric effect dominates.



Most gamma-rays are of high frequency like this one.
But our effect does not work here.
Other detectors are worse.

66kev of Cs137 in many books explaining sum-peak effect.

Note that energy is a photon concept. Absorption of NaI(Tl) from *Evans*

These gammas gave an unquantum effect.
The source needs to be one-at-a-time.
There are few opportunities to see the effect.

Success with many different tests

For an experimenter, trying to prove one is wrong is the name of the game.

Detectors. NaI(Tℓ) and BGO scintillators. High purity germanium.

Isotopes. Cd-109, Co-57, Am-241, Na-22.

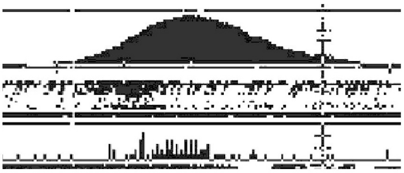
Geometries. Two detectors in beam-split and tandem.
Single detector sum-peak analysis.
Two detector gated sum-peak analysis.
Three detector coincidence with Na-22.

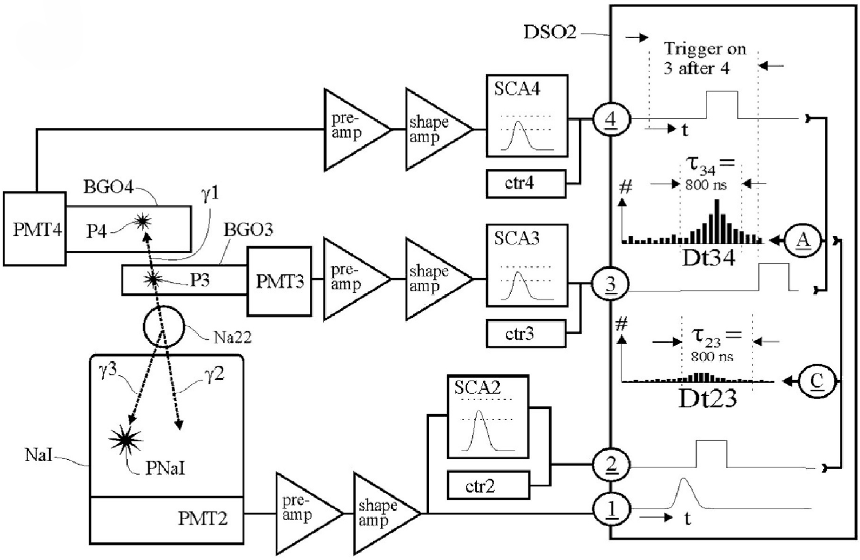
Tests to eliminate artifact. Pb fluorescence, stimulated emission, PMT echos.

Coincidence electronics.
AND gate, time-to-analog converter, LeCroy Scope.

Function of physical variables. Performed but require more testing.
Hot and cold beam-splitter comparison.
Magnetic field on ferromagnetic, diamagnetic, paramagnetic beam-splitters.
Crystal beam-splitters at different angles.
Chemistry of source, electroplated, crystalline.
Function of distance tests.

Triple coincidence test with Na-22



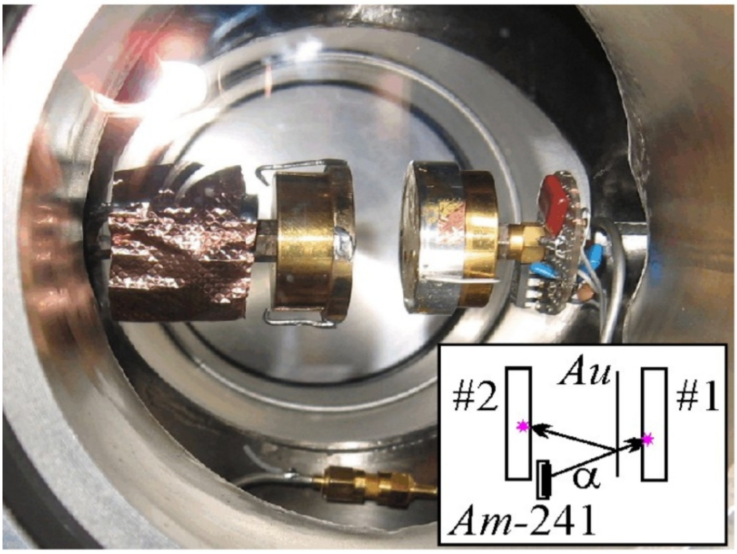


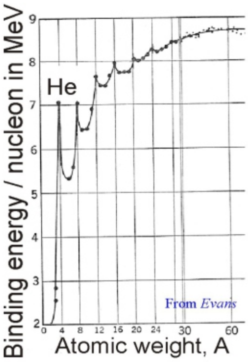
To resolve wave-particle duality is to resolve it for both matter and light.

Split the atom like a wave.

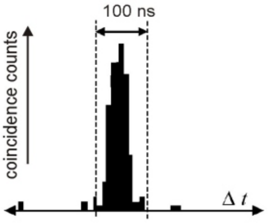
Same kind of beam-split-coincidence test.
Now we use alpha-rays, **helium**.

105 x chance
& 6 x chance





We only have 5.5 MeV
from our *Am*−241.
It takes 14 MeV to split helium.



It also passed the true coincidence test.

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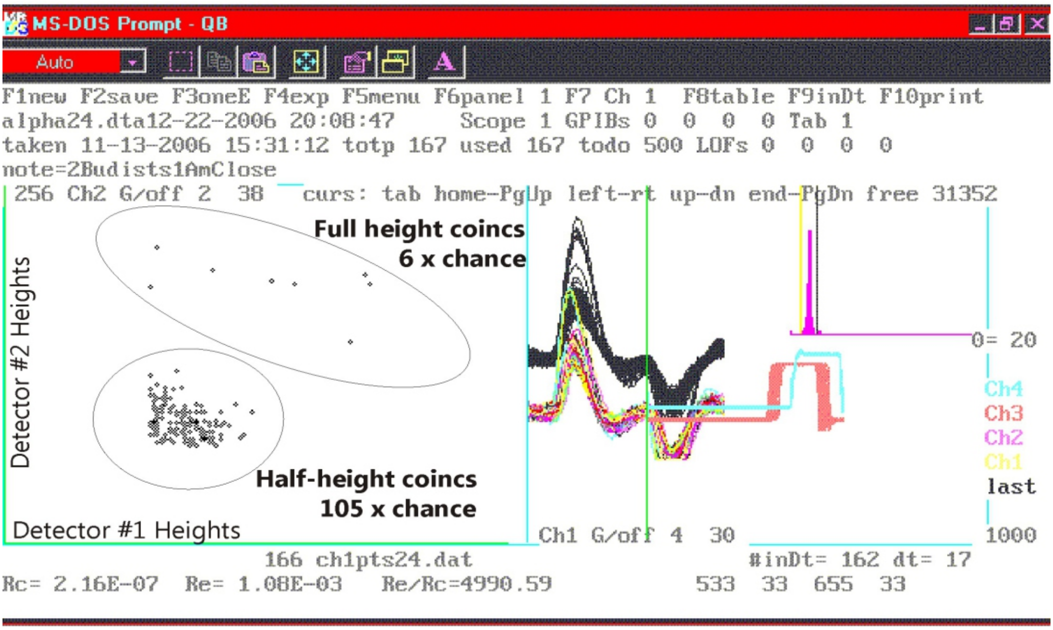
Computer automated alpha-ray split



```
F1new F2save F3oneE F4exp F5menu F6panel 1 F7 Ch 1  F8table F9inDt F10print
alpha24.dta12-22-2006 20:08:47     Scope 1 GPIBs 0  0  0  0 Tab 1
taken 11-13-2006 15:31:12 totp 167 used 167 todo 500 LOFs 0  0  0  0
note=2Budists1AmClose
 256 Ch2 G/off 2  38   curs: tab home-PgUp left-rt up-dn end-PgDn free 31352
                                                                        0= 20
                                  Ch1 G/off 4  30                       1000
                  166 ch1pts24.dat                #inDt= 162 dt= 17
Rc= 2.16E-07  Re= 1.08E-03   Re/Rc=4990.59     533  33  655  33
```

Full height coincs
6 x chance

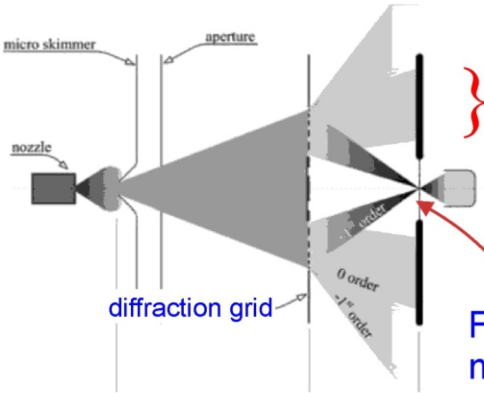
Half-height coincs
105 x chance

Detector #1 Heights

Evidence by others for

Helium-wave interference

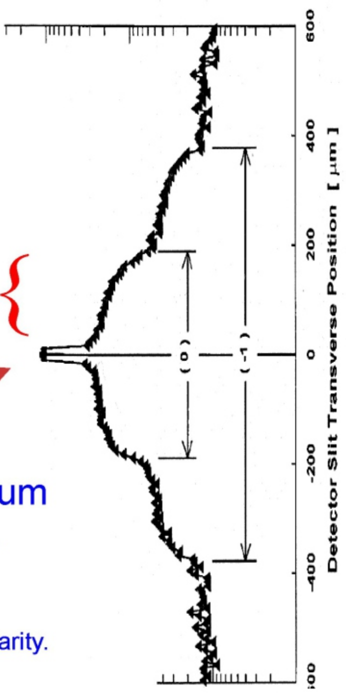
Journal of Microscopy, Vol. 229, Pt 1 2008, pp. 1–5
Imaging with neutral atoms — a new matter-wave microscope
M. KOCH. Their graphics.



diffraction grid

} Particles {

Focused helium matter-wave.



Two-states, like a soliton. Not like complementarity.

Threshold Model

Equations for experiments famous for wave-particle duality have ratios
***h/m, e/m, e/h*.**
Ratios and thresholding can replace quantization.

	Quantum Mechanics	Threshold Model
Matter wavelength	$\lambda_{\text{phase}} = \dfrac{h}{m\varsigma}$	$\lambda_{\text{group}} = \dfrac{Q_{h/m}}{\varsigma_{\text{group}}}$
Photoelectric	$h\nu_{\text{L}} - h\nu_0 = \dfrac{m\varsigma^2}{2} = e\text{V}_0$	$Q_{h/m}(\nu - \nu_0) = \dfrac{\varsigma^2_{\text{group}}}{2} = Q_{e/m}\text{V}_0$
Compton	$\Delta\lambda = \dfrac{h\,(1 - \cos\theta)}{mc}$	$\Delta\lambda_{\text{group}} = Q_{h/m}\,\dfrac{1 - \cos\theta}{c}$
Lorentz force	$F = ma = e\,(\varsigma \times \boldsymbol{B})$	$a = Q_{e/m}(\varsigma_{\text{group}} \times \boldsymbol{B})$
Aharonov-Bohm	$\Delta x = \dfrac{e\,L\lambda Bw}{h}$	$\Delta x = Q_{e/h}\,L\lambda_{\text{group}}Bw$

Other equations with odd ratios of these constants are not about spreading waves.

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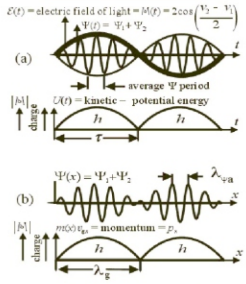
Derivations by threshold model

Photoelectric effect

The factor of two correction.
Charge is the envelope of Ψ.
Two beats per modulator wave.

$$\boxed{2\nu_{\text{light}} = \nu_{\text{beats}}}$$



Balmer Eq: $\nu_{\text{light}} = \nu_2 - \nu_1$ implies beats.

Velocity $= \nu_{\text{beats}}\lambda = 2\nu_{\text{light}}\lambda$

$\lambda = V / 2\nu_{\text{light}}$. Now use DeBroglie's

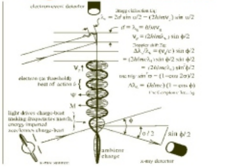
$\lambda = h / mV = V / 2\nu_{\text{light}}$

$h\nu_{\text{light}} = mV^2/2$.

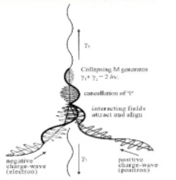
Now rewrite with the Q ratio.

Compton effect

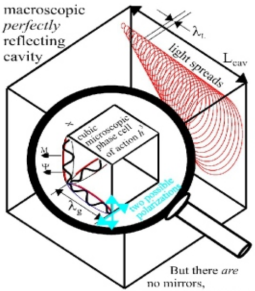
Light reflects from beats



Pair creation/ annihilation



Black body



But there *are* no mirrors, especially in outer space.

Recent experiments of others were re-analyzed, revealing their flaws.

We used this theory to predict the gamma and alpha-split experiments.

Matter-wave can hold itself together or spread like a wave. A soliton.

Acknowledgment to
Ken Kitlas for assistance.

Eric S Reiter
2017
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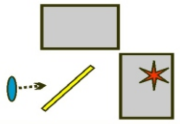
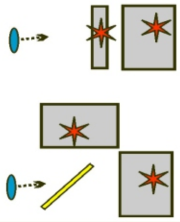
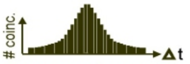
Review







	light	gamma	alpha	other stuff
Beam-split geometry	others QM	ER UNQ	ER UNQ	
Tandem geometry does the same thing.		ER UNQ		QM
One-at-a-time source.		ER & others QM	ER & others QM	others QM
Two-for-one unquantum effect		ER UNQ	ER UNQ	

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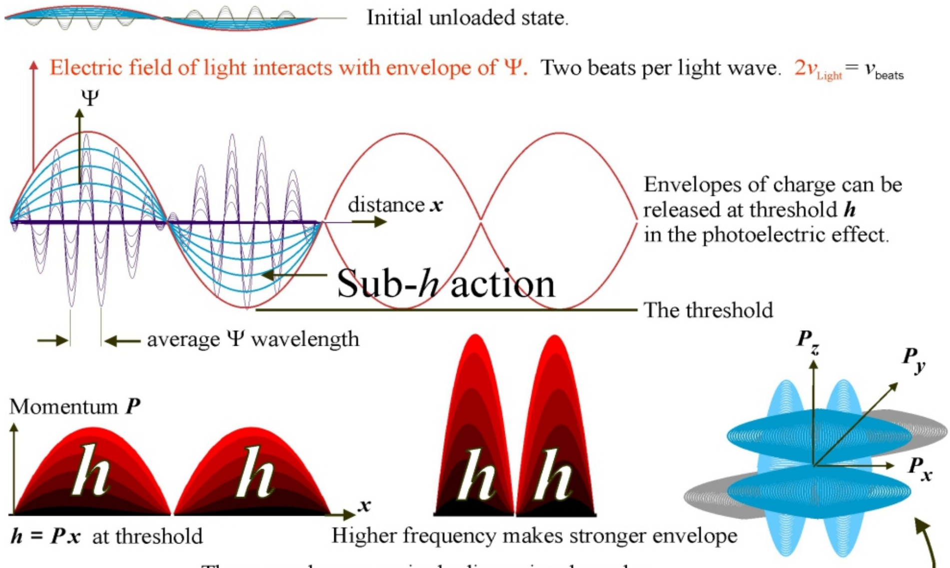
ER = Eric Reiter, QM = quantum mechanics, UNQ = unquantum effect

Models	electromagnetic, light	matter, rest mass
classical wave: interference, spreads	light waves	water, sound
classical particle: holds together		planet, large molecule
QM particle: wave-particle duality	probability calculation “photon” clicks	probability calculation electron, proton, atom, etc.
Threshold model: Add wave properties. Accumulation hypothesis, Loading theory.	classical light waves clicks	two-states soliton charge matter-wave Clicks.

There are no photons (too confusing to redefine).
Light is classical.
Matter with rest mass is solitons.
There is no entanglement. No spooks.

A *threshold* interpretation of Planck’s constant

Charge is the envelope of Ψ, undersood from difference frequencies in atomic theory.



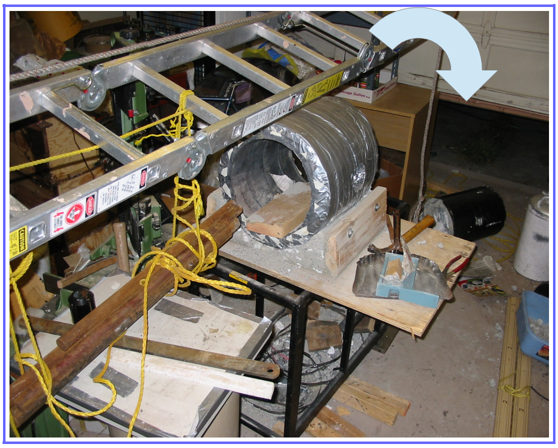
These envelopes are single dimensional graphs.
3D is consistent with h^3 construct of Bose when applied to matter waves.

Photo Essay
for Photon Violation Spectroscopy

This is an early setup using sodium iodide/photomultiplier detectors. A two inch detector is on the left. A detector with a hole through its side is to the right.

I was concerned about the noise from cosmic rays and wanted to do sensitive measurements, so I took the extraordinary effort to build a lead shield to make sure my chance-defying effect persisted the same way inside and outside the shield.

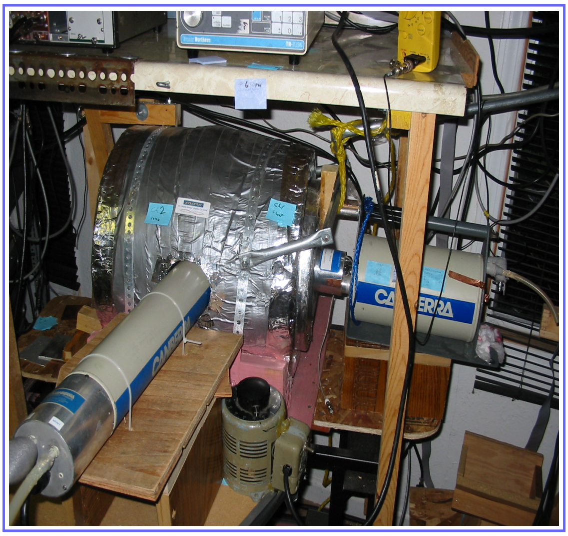
Lead bricks were bent and placed around a concrete cylinder mold. Although I took precautions against the concrete becoming stuck... it got stuck. Here I set up my hydraulic floor crane sideways in an attempt to pull it loose. In photo is my wife Miriam with safety glasses. I did not put her in danger here.



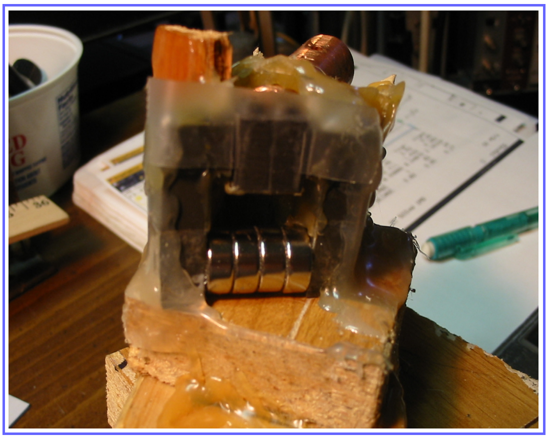
After several failed attempts at pulverizing, yanking, and pushing, I arranged a battering ram of steel bars hanging from a swinging ladder suspended from the ceiling. After about 30 minutes of wild smashing, the mold popped out. It is the black cylinder on the floor. It took all day to get the mold out.

Photo shows two High Purity Germanium (HPGe) detectors in the lead shield. The Dewar on the left is feeding liquid nitrogen into a detector. The detectors and Dewar were purchased "as is," performing high risk gambling on *ebay*.

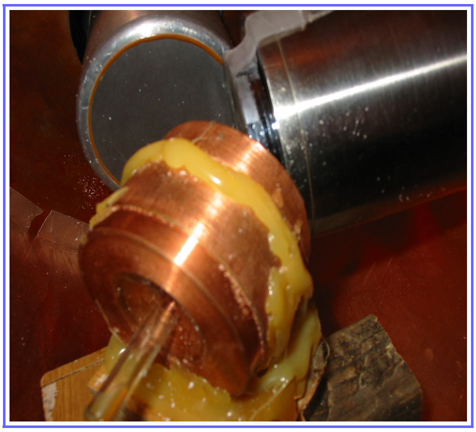
Here is the same two-HPGe detector setup as shown above. The variac powered a heater element inside the dewar that would create pressure for transferring the cold fluid.

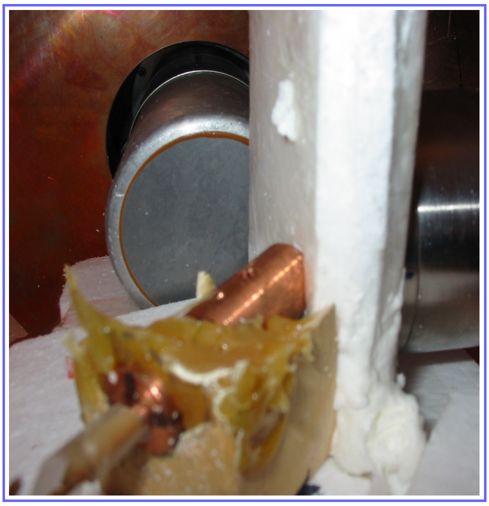


This magnet system applied a field to a ½ inch cube that gamma-rays were aimed through. The copper collimator is seen at the top of photo. This was tested with carbon and a ferroelectric ceramic, as described in *Photon Violation Spectroscopy*. The test was done inside the lead shield. You can see I am a big fan of hot glue.



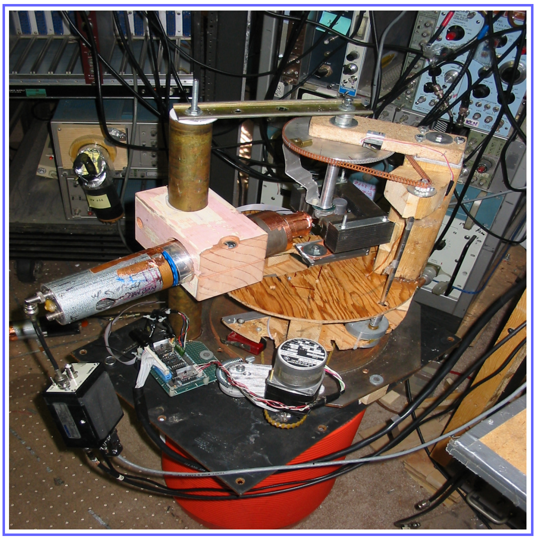
Here inside the lead shield, a disk of aluminum is a beam-splitter in front of the right-side detector. The copper cylinder is a collimator.

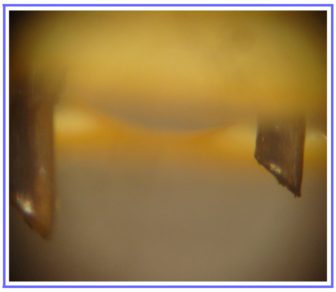




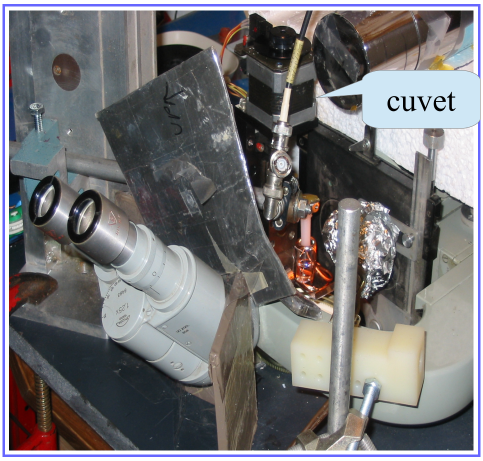
Here inside the lead shield is how I discovered how temperature modulates the unquantum effect. The detectors are the same HPGe as shown in the above photo. The copper cylinder is a gamma collimator. *Styrofoam* surrounds an aluminum plate that faces the right-side detector. The plate extends down to a *styrofoam* tub of liquid nitrogen. Another test was done with no liquid nitrogen for comparison. A temperature sensor was used. The unquantum effect worked twice as good cold, as predicted.

This was an elaborate method of applying a magnetic field and measuring angle information at the same time. There are two axes controlled by a computer program I wrote to drive stepper motors. One axis orients the magnet to the detector, and the other axis rotates the scatterer within the magnet. The apparatus also worked without the magnet to obtain angle effects. The second detector is smaller inside the iron core. Most of this apparatus was used earlier inside the lead shield. It was found that the shield was not necessary. Modules from my old business, Computer Continuum, were employed for motion control and A/D conversion. In the left background is the scope and photomultiplier arrangement used in previous tests to eliminate sickly-shaped pulses.

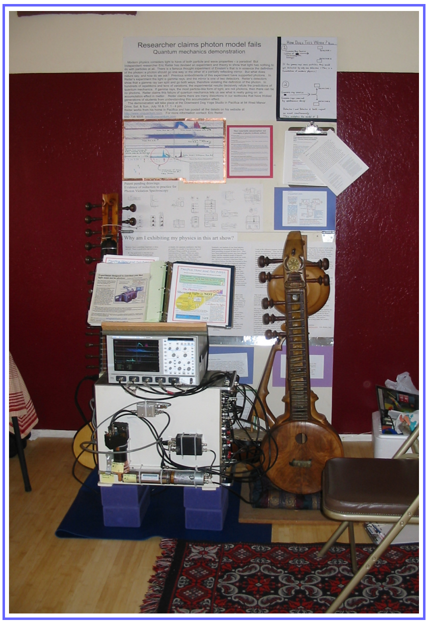




This shows a view through the microscope of the apparatus shown below. It is an electroplating machine with feedback to control the depth that electrodes penetrate the solution. The thin fuzz of black on the right electrode tip is Cd-109. These electrodes were replaced with platinum wire in a later electroplating effort that worked better. There was a translation stage for both electrode height and cuvet height.



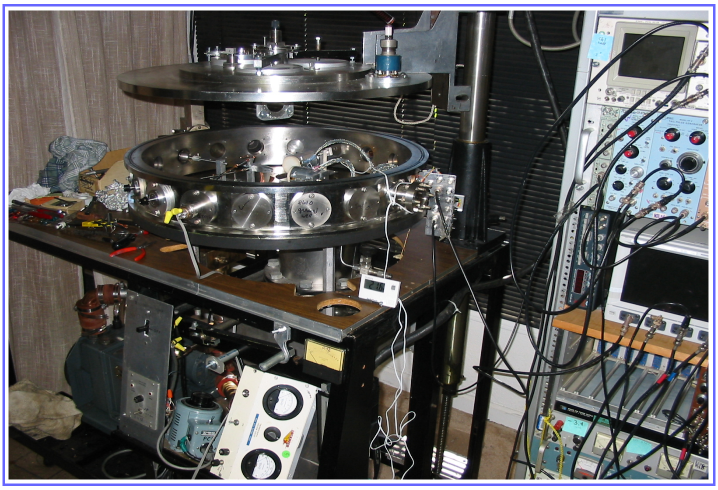
The electroplating effort was intended to concentrate the volume of Cd-109. I discovered that the electroplated source in a tandem-geometry coincidence test gave a startlingly different unquantum effect from a normally purchased Cd-109 source. A metal Cd-109 was made by this electroplating apparatus. A salt Cd-109 was made by simply letting a solution evaporate. The scintillator detector, at top, was engaged by sliding the electroplated electrodes up to measure how much Cd-109 was electroplated. Ken Kitlas provided chemistry advice. A motor under feedback control from conductivity is at the top of the vertical translation stage clamped to the table.



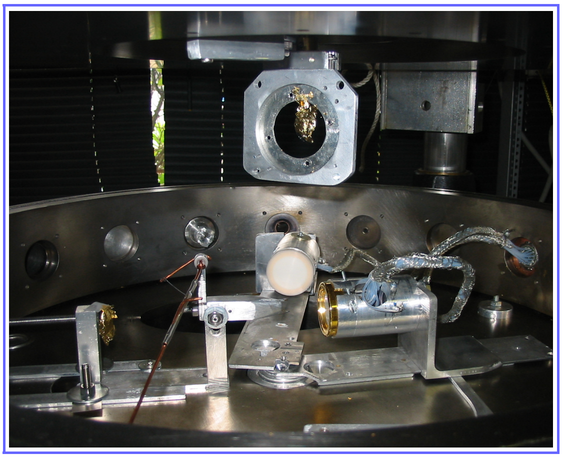
Here a portable gamma-split experiment was brought to a small art show. The *LeCroy* scope sits atop a nuclear instrumentation module (NIM) rack placed on its side. The detectors in tandem geometry are on the white board below the scope. The whole apparatus sits on yoga blocks, on a yoga mat, in a yoga studio, where the art show was held. The apparatus was performing the very difficult *gamma-split* yoga pose. My musical instruments are also shown; sitar to left, neurotic cello near NIM, south Indian veena to right. I built those in my grade school days. The veena was a high school wood shop project. This was my second public demonstration. My first public demonstration was at the *San Francisco Tesla Society* Dec 14, 2003. A third public demonstration was at the 2007 *Maker Faire* in San Mateo, CA.

Supplemental Photos for Particle Violation Spectroscopy Project.

The alpha experiments required a vacuum chamber. The chamber pictured was originally a coating machine at a Stanford University stockroom, gifted by a generous employee there. It was much more complicated than pictured here. I rebuilt it to my needs. Shown here is how I winched it into our home front door. The lab is located in the front .

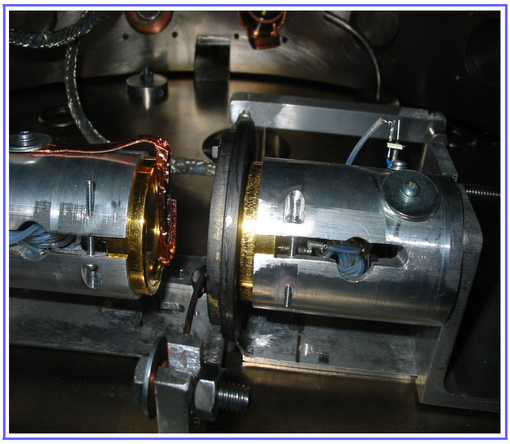


Here is the Stanford machine ready for alpha work. The top is on a motorized lift.



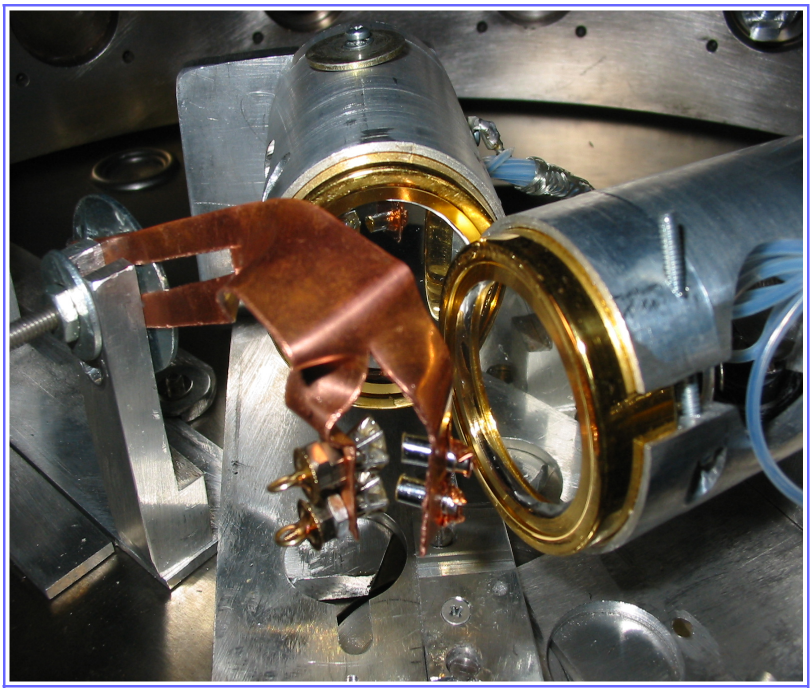
I built an elaborate system of holding the detectors, source, and beam-splitter foil mount. I did not know what geometry would work because this experiment has never been done before. The arrangement was somewhat overbuilt and the chamber was too large to pull a high vacuum due to many slow leaks. I tried many alpha splitting foil types and a few gases as beam-splitters. Gases tested were propane, helium, and oxygen with poor results. Propane had a measurable effect but was not sensational enough for me to report.

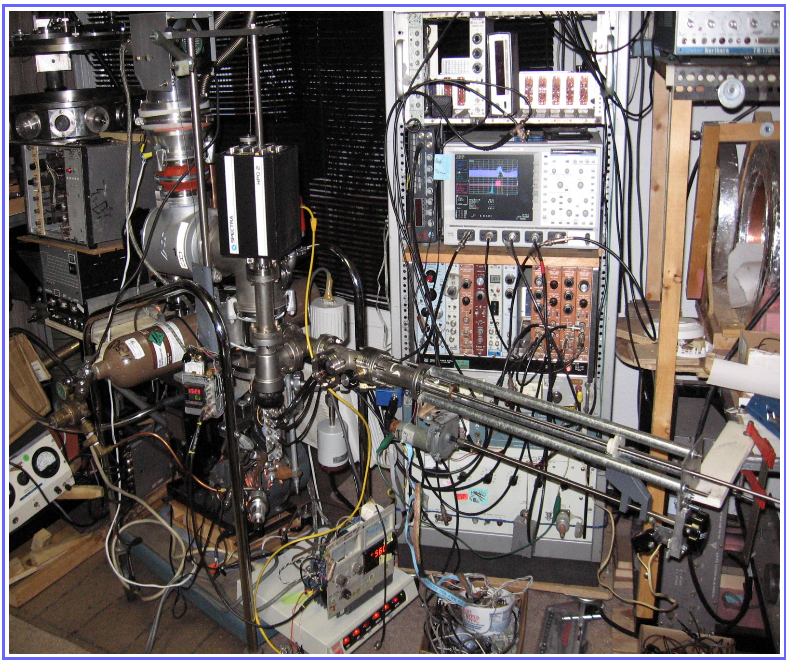
The detectors used were fully shielded and contained internal pre-amplifiers. These detectors were surface barrier Ortec "DIAD" (discriminating industrial alpha detector) type that I obtained from a very nice *ebay* vendor.



This is one of my early arrangements that worked for splitting the alpha. The americium alpha source is suspended from the left detector. The beam-splitter is gold-leaf mounted on a ring upon on the right detector.

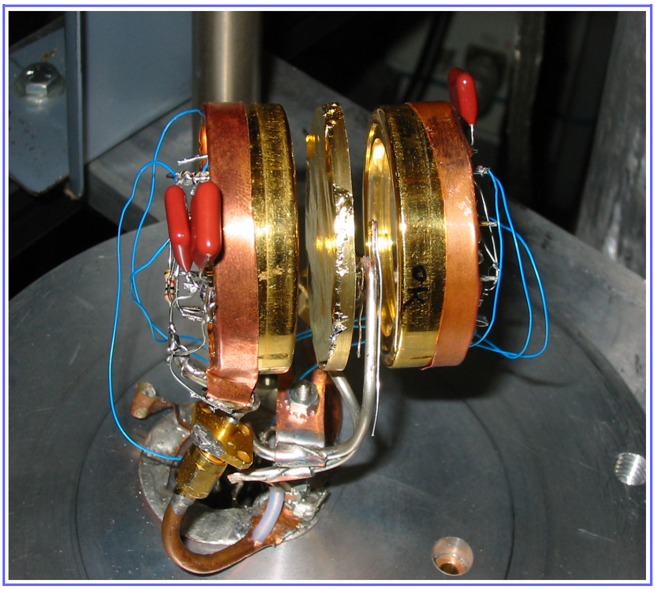
This incredible setup used two diamond earrings my wife inherited from her Aunt Sylvia. Two alpha sources at the ends of tube-collimators direct alphas at the diamonds. This experiment ran 3 days to obtain a convincing unquantum effect. Aunt Sylvia's diamonds split the alpha in two directions of reflection at once, defying the particle model of the atom. The gold split effect and the diamond split effect that I witnessed with this machine were so incredible that I decided to improve and rebuild the entire setup.





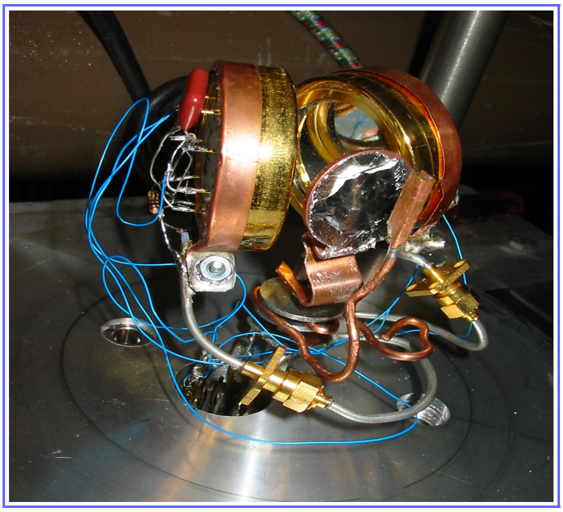
There was much work and many upgrades between experiments to get to the stage seen in this photo. It is a completely rebuilt system mounted on an oscilloscope cart. The long extension on the right side of the chamber moved the source under motorized control in search of distance effects. This idea was inspired by the distance effect I measured using gamma-rays. This research obviously requires more work. The pressure bottle is helium, useful for finding leaks, and for hunches I had about how helium would interact with the alpha. Alpha is ionized helium.

This is two DIAD detectors mounted to go inside the chamber pictured above. The gold foil is on a ring between the detectors. The source is on a stem to the right of the gold foil. This arrangement gave good results, but I remained skeptical. The signal wires were coaxial hard-line that supported the detectors and were bendable for position adjustment.

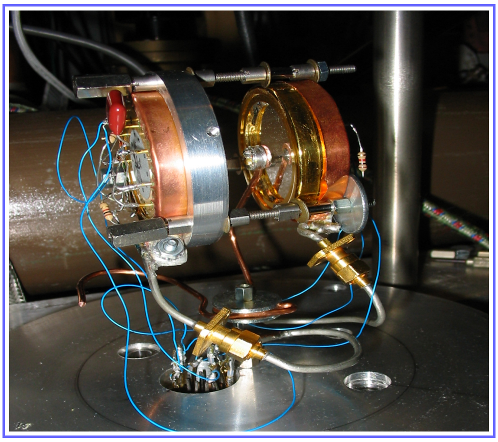


This experiment has the alpha source suspended on a stem to aim alpha-rays at silver-leaf, in a symmetrical type of beam-split test. This geometry did not work well for any kind of foil.

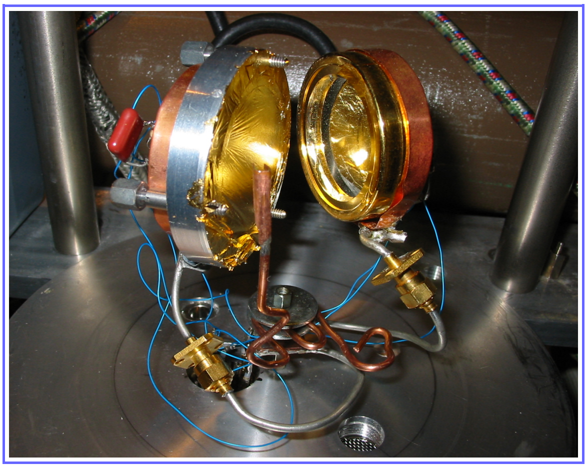
In this and other geometries, I tried gold, silver, palladium, copper and different alloys of gold. Gold and its alloys revealed the best unquantum effects.



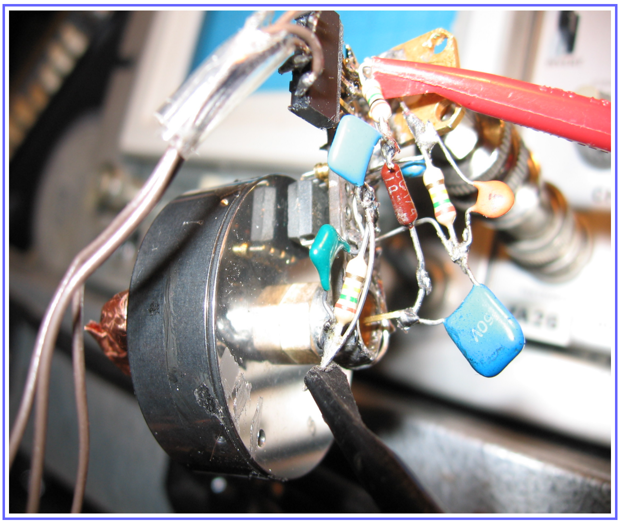
Here is a successful arrangement using a ring holding gold-leaf foil on the left detector. The foils used were from art supply vendors.



This is a geometry with the same gold-leaf beam-splitter and an americium source suspended in front. I was looking for a specular type reflection to the right side detector. This method worked well. By working well, I mean a singly emitted alpha must have split to go forward to the left detector AND to the right detector to cause coincidences at rates greater than accidental chance.



(next page) My effort to rebuild the system called for building preamplifiers inside the vacuum chamber. This allowed me to use other detectors that did not have the built-in amplifier. The alpha source is in a copper piece on the left of the detector. The dual-



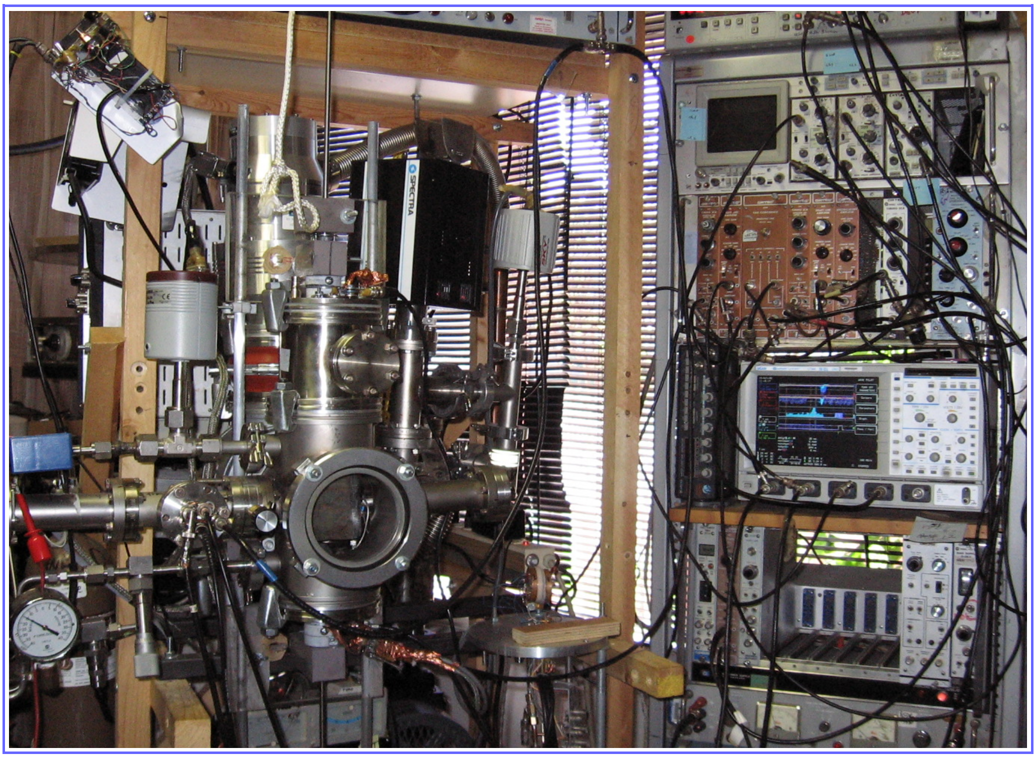
inline-package, DIP, op amp chip is socketed seen here above the detector connector. It took much work to optimize the components that would allow me to preserve the pulse-shape from each alpha interacting with the detector. Commercial amplifiers did not preserve the pulse-shape I wanted to study; they optimized response-time at the sacrifice of pulse-shape. My amplifiers were 4 times faster than those inside the DIAD. The amplifiers have a limiter feature not found on commercial amplifiers. I wanted to eliminate large pulses from cosmic rays that might cause clipping in the next stage amplifier. I struggled with hundreds of component adjustments for about a month to perfect the design, and then re-built it cleanly. The pulses from alpha detectors are much smaller than the pulses from photomultiplier tubes used for the gamma experiments.

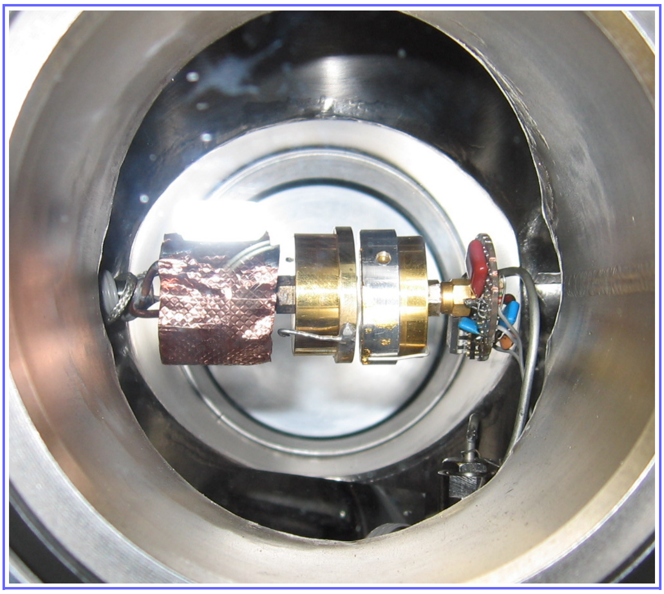
I decided to rebuild the system for the fourth time. I acquired at low cost, two stainless steel vacuum elbows and cut each corner off so it could be welded into a cross-geometry. Here my nephew Yuri Reiter is *cutting corners* at his metal fabrication business.

Here is the welded vacuum chamber. It is actually a 6 way cross including two smaller conflat fittings.

It's impossible to describe the detail and heartache I had to go through to make everything work. I built many of the electrical, mechanical and gas feedthroughs. Here is one of my workbenches showing two end caps under construction for the chamber of the previous photo.

Below is the completed alpha splitting machine that I had on display for my equinox party and demonstration of 2006. There is a lead block seen in the chamber window shielding the detectors. I found this was not necessary if I used the small Ortec-brand detectors. The LeCroy oscilloscope to the right is showing an alpha pulse-height spectrum. Several gauges and features shown here were not operational. The lines are terminated to eliminate reflections. It looks complicated because I test many ways.





This was the best geometry found for splitting the alpha. The detectors are 1 inch diameter Ortec type mounted on my amplifiers. The alpha sources are mounted on a ring surrounding the front of the left detector, and the gold-foil is on a ring on the right detector. The detectors are mounted on feedthrough shafts to control the distance between them.

There are two ways I split the alpha: with gold-foils in a beam-splitter geometry, or with diamonds in a reflection geometry.

Splitting the alpha by reflecton from diamonds remains mysterious. It worked several times with the earrings as shown above, but with other diamonds it just showed random time graphs. We suspect the cut and crystal orientation is important. Do not attempt this test first. For anyone attempting to reproduce the unquantum effect, they should start with gamma-rays from Cd-109 in tandem geometry.

I spent two years (as of this 2007 writing) full time to construct, write-software, rework, and retest to convince me there were no artifacts or alternative explanation to these alpha tests. I performed <u>many</u> more tests than those mentioned here.

The alpha-split effects I discovered are the most sensational result of any experiment I know of, mine or otherwise. When they try to teach you about wave properties of particles, you can laugh like I do. Particles do not diffract. Particle-like quantization is replaced by a threshold model.

ER 2007, edit 2023

A New Radiation Hypothesis

by Max Planck

Given in the seminar of 1911

February 3

Notes: Translated by R A Wolf and Eric Reiter.
This is much easier to read if one realizes that a Planckian oscillator is energy at a set frequency that is within matter. We have emphasized some of Planck's work in red. [Blue is ER]

Gentlemen! Fully ten years ago I had the honor of lecturing here on the foundations of a theory of heat radiation, one of whose essential assumptions is that, in the case of the generation of heat rays, a characteristic role is played by certain finite, indivisible quanta of energy, or elements of energy, of the size $\varepsilon = h\nu$, where h is the elementary quantum of action, 6.55×10^{-27} erg sec [1].

As peculiar as this assumption is, when contrasted with the well-known and established presentations of electrodynamics and the theory of electrons, so many consequences follow from it, not only for the laws of black-body radiation but also for the elementary quanta of electricity and matter, and also thanks to the researches of A. Einstein and W. Nernst, for the well-established specific heats of solids and liquids, that it appears quite justified to proceed further along the path already laid down and to lift the veil which still lies over the quanta of energy.

Of course, from the very beginning I have unceasingly worked to elaborate the conceptions of the processes of absorption and emission of heat radiation, but unfortunately without significant success. Difficulties arose from many sides – difficulties whose significance one may appreciate when one considers that even the validity of the fundamental equations of Maxwell-Hertz electrodynamics was brought into doubt, according to which any local electrodynamic disturbance is propagated as a spherical wave in all directions. In my opinion, however, one need not now go that far but should instead, not jump to risky hypotheses, so that one can live with Maxwellian electrodynamics, which is so well established by the most precise optical measurements.

Such considerations encourage my reporting to you now on a new radiation hypothesis. I have developed it partly in response to criticisms of my theory by other researchers, of which the most recent is that of H. A. Lorentz [2], and I ask you to consider this hypothesis, which, I believe, may be rather fruitful.

For greater clarity, allow me first to review the conceptual development of my theory heretofore. I have assumed linear Hertzian oscillators as the centers for the absorption and emission of radiant heat. The excitation of such an oscillator with characteristic frequency v produced by that component $\mathfrak{E}$ of an incident electric field which lies along the oscillator's axis. Namely, if J is the time average of the square of $\mathfrak{E}_Z$:

$$\overline{\mathfrak{E}_Z^2} = J$$

and if we decompose J into its Fourier spectrum

$$J = \int_0^\infty \mathfrak{J}_\nu \, d\nu,$$

then the quantity $\mathfrak{J}_\nu$, which I have called the intensity of the vibration exciting the oscillator, yields the energy absorbed by the oscillator in the time *dt:*

$$\frac{3\,c^3\,\sigma}{16\,\pi^2\,\nu}\cdot\mathfrak{J}_\nu\cdot dt. \tag*{1)}$$

where c is the speed of light and σ is a small constant, namely the logarithmic decrement, due to damping of the amplitude of the vibration of the oscillator.

In the case of isotropic stationary black-body radiation, the spatial density u_V of the frequency v depends upon $\mathfrak{J}_\nu$ according to the relation

$$\mathfrak{u}_\nu = \frac{3}{4\pi}\mathfrak{J}_\nu. \tag*{2)}$$

On the other hand, the energy emitted by the Hertzian oscillator in the time dt is

$$2\sigma v U\,dt \tag*{3)}$$

where U is the vibrational energy of the oscillator.

In a field of black-body to the energy emitted, hence radiation, the energy absorbed is equal to the energy emitted, hence

$$\mathfrak{u}_\nu = \frac{3}{4\pi}\,\mathfrak{J}_\nu = \frac{8\,\pi\,\nu^2}{c^3}\cdot U. \tag*{4)}$$

In order to proceed from this equation to the laws of black-body radiation, we require the concept of temperature. This can be obtained from the general thermodynamic relation among temperature T, energy U, and entropy S

$$\frac{1}{T} = \frac{dS}{dU}, \tag*{5)}$$

in combination with the equally general relation between entropy and probability

$$S = k\ \mathrm{In}\ W \tag*{6)}$$

where W is the probability that the oscillator will possess energy U and where k is 1.346×10^{-16} ergs per degree.

According to this, the problem comes down to calculating the probability that an oscillator of frequency v would have a given energy U. I attempted to solve this problem by conceiving of U as a statistical average and I investigated the distribution of a very large quantum of energy NU among N identical oscillators. In order to arrive at a definite, finite value for this probability, I considered NU as the sum of a large number of identical, indivisible elements of energy of size $\varepsilon = hv$, hence:

$$N\,U = P\,\varepsilon \qquad 7)$$

and I assumed that, for each possible distribution, or complexion, a definite number of elements of energy (possibly none) would fall to each oscillator. Letting W_N denote the number of all possible distinct complexions, we have

$$W_N = \frac{(N+P)!}{N!\;P!} \qquad 8)$$

and the corresponding entropy

$$S_n = \mathrm{k} \ln W_N$$

and so the corresponding entropy for a single oscillator is

$$S = \frac{S_N}{N} = k\left\{\left(1+\frac{P}{N}\right)\log\left(1+\frac{P}{N}\right) - \frac{P}{N}\log\frac{P}{N}\right\}, \qquad 9)$$

from which, by Equation 7, we get

$$S = k\left\{\left(1+\frac{U}{h\,v}\right)\log\left(1+\frac{U}{h\,v}\right) - \frac{U}{h\,v}\log\frac{U}{h\,v}\right\}, \qquad 10)$$

And finally, by substituting into 5), we get

$$U = \frac{h\nu}{e^{\frac{h\nu}{kT}} - 1}, \tag{11}$$

for the energy of the oscillator, from which, by 4), we get for the spatial density of the black-body radiation:

$$\mathfrak{u}_\nu = \frac{3}{4\pi}\mathfrak{J}_\nu = \frac{8\pi h\nu^3}{c^3} \cdot \frac{1}{e^{\frac{h\nu}{kT}} - 1}. \tag{12}$$

The derivation above would naturally be immediately intelligible if we assumed that the actual energy U of each oscillator were, at each moment, an integral multiple of ε and therefore could change only by discrete amounts. I have attempted to elaborate this assumption further and even a year ago I expressed the hope that it could be accomplished [3]. However, weighty misgivings came to the fore. One of the most difficult questions is, "How can such an oscillator absorb an energy element ε if it is hit by a heat ray?" It must absorb it from the incident exciting ray, and indeed suddenly and completely. Therefore, if the exciting ray, which could have an arbitrarily small intensity, is too small, then it could not be absorbed at all. This leads to the idea that for the oscillator a certain threshold exists, below which it is capable of no excitation at all, and above which the absorption begins with a whole element of energy. Moreover, as I belatedly emphasize here, M. Reinganum [4] has already come upon the idea of such a threshold in his oscillator model.

However, the difficulties are not thereby removed. For, the taking up of a finite quantum of energy from a finite intensity of radiation can occur only in a finite time, which will be all the longer, the smaller is the intensity of the exciting vibration $\mathfrak{J}_\nu$ when compared with the quantum ε of energy.

Now, the quantum of energy $\varepsilon = h\nu$ becomes larger with the frequency, whereas, on the other hand, the intensity $\mathfrak{I}_\nu$ falls off so rapidly that, for short waves, the time mentioned above must ultimately become immense. And this contradicts the assumption made; for if the oscillator has begun to absorb energy and if the incident radiation should suddenly cease, then the oscillator would be prevented from taking up the complete quantum of energy which it requires from time to time for the production of the statistical mean value of U.

In my opinion, these considerations lead us to regard the absorption as proceeding completely continuously and, correspondingly, to regard the expression 1) for the energy absorbed as exact.

With that we remove the assumption of the absolute discontinuity of the energy U of the oscillator, and U need not be only an integral multiple of the quantum ε but can assume any value between zero and infinity. At the same time the thought of connecting probability with the absorbed energy becomes irrelevant. Instead, the value of the absorbed energy is immediately given by Equation 1).

In addition, the hypothesis is suggested that the emission of energy from the oscillator, on the other hand, occurs in jumps, according to the energy quanta and the laws of chance, quite independently of any simultaneous absorption. The emission of energy proceeds spontaneously, in determined quanta of size $\varepsilon = h\nu$, and the probability that an oscillator of characteristic frequency ν will emit an elementary quantum of energy in the sufficiently small [5] time dt is equal to

$$\eta\, n\, dt \qquad 13)$$

where η is a constant, to be determined shortly, depending only on the nature of the oscillator, and where n is the number of whole energy elements ε

which the oscillator possesses; i.e. n is that nonnegative integer for which $U/_{\varepsilon} - n$ is a proper positive fraction (<1). Then we can write

$$U = n\varepsilon + \varrho \qquad 14)$$

where $0 < \varrho < \varepsilon$.

For example, if U is smaller than ε, then $n = 0$ and the oscillator will emit nothing at all. On the other hand, if U is large, we can neglect ϱ in comparison with $n\varepsilon$ and regard the emitted energy as proportional to U, as was done earlier.

We next investigate the stationary state of vibration for the oscillator when it is in the field of black-body radiation. In that case, we cannot set the energy absorbed in the time dt equal to the energy emitted in that same span of time, for the former is continuous and the latter is discontinuous. In fact, the equilibrium is a statistical one and relates to the average values of the absorbed and emitted energies over long times. Under this assumption, it follows from 1), 13), 14), as a condition for the stationary state, in obvious notation, as

$$\frac{3c^3\sigma}{16\pi^2\nu}\cdot\mathfrak{J}_\nu = \eta\,.\,\bar{n}\,.\,\varepsilon = \eta(\bar{U} - \bar{\varrho}).$$

The mean value ϱ is clearly $\varepsilon/2$ and therefore

$$\mathfrak{J}_\nu = \frac{16\pi^2\nu\eta}{3c^3\sigma}\left(\bar{U} - \frac{\varepsilon}{2}\right).$$

Since for large *Ü* this last equation must agree with 4), it follows that the emission coefficient:

$$\eta = 2\sigma\nu \qquad 15)$$

and the previous equation, together with 2), yields

$$\mathfrak{u}_\nu = \frac{3}{4\pi}\mathfrak{J}_\nu = \frac{8\pi\nu^2}{c^3}\left(\overline{U} - \frac{h\nu}{2}\right), \qquad 16)$$

in noticeable contrast to 4).

Now we consider again the determination of the temperature. For this we proceed just as we did above; i.e., we use the general thermodynamic equations 5) and 6) and ask for the probability that the oscillator will possess mean energy $\ddot{U}$. We will get this probability by considering again the distribution of a very large quantum $N\ddot{U}$ of energy among N identical oscillators. But now, in contradistinction to the earlier considerations, the energy U of an oscillator may possess values other than a whole multiple of ε. For the energy U of an oscillator at any given time t is determined uniquely from its energy U_0 at time $t = 0$ and the energy that it has absorbed and emitted in the span of time t. Moreover, for sufficiently large t, the initial energy U_0 becomes irrelevant to the determination of the probability of the energy U and can therefore be given an arbitrarily fixed value. Likewise, the absorbed energy is completely determined by 1) and is the same for all oscillators in the field of black-body radiation. Spatial and temporal fluctuations of the intensity of the exciting radiation will be present but will have no influence, as a little thought shows [6]. Therefore, considerations of probability relate only to the emitted energy, and this is, by our hypothesis, a whole multiple of ε. Hence, in the expressions 14) for the energies of the N oscillators, namely,

$$U_1 = n_1\varepsilon + \varrho_1\,, \quad U_2 = n_2\varepsilon + \varrho_2 \ldots$$

it is only the integers $n_1, n_2 \ldots, n_N$ that are to be subjected to considerations of probability. But since the total energy is given, then so is given:

$$U_1 + U_2 + \ldots = NU$$

then it is also the sum of the integers:

$$n_1 + n_2 + \cdots = P = \frac{(U_1 + U_2 + \cdots) - (\varrho_1 + \varrho_2 + \cdots)}{\varepsilon},$$

$$P = \frac{N\left(\overline{U} - \frac{\varepsilon}{2}\right)}{\varepsilon} \qquad 17)$$

and therefore, just as before, it is a question of distributing a large number *P* of energy elements among *N* oscillators of the same type. We therefore get for *S* again the equation 9), and further, using 17):

$$S = k\left\{\left(\frac{\overline{U}}{h\nu} + \frac{1}{2}\right)\log\left(\frac{\overline{U}}{h\nu} + \frac{1}{2}\right) - \left(\frac{\overline{U}}{h\nu} - \frac{1}{2}\right)\log\left(\frac{\overline{U}}{h\nu} - \frac{1}{2}\right)\right\}. \qquad 18)$$

The substitution in 5) now yields:

$$\overline{U} = \frac{h\nu}{2}\cdot\frac{e^{\frac{h\nu}{kT}} + 1}{e^{\frac{h\nu}{kT}} - 1}, \qquad 19)$$

This is different from equation 11) by the additive constant *hv*/2. [With some algebra eq 11 + *hv*/2 = eq 19. This *hv*/2 is the average of what is known as zero-point energy. I have been calling zero-point energy the energy of a pre-loaded state.] The laws of black radiation result from 19) and 16) again as well as in 12) above.

The consequences of the new hypothesis require for black radiation no modification, however it does for the energy of a resonating oscillator. Because for *T* = 0, *Ü* will not be equal to 0, but equal *hv*/2. This residual energy of an oscillator remains at absolute zero temperature on average. It cannot be lost because if *U* is less than *hv* there is no energy emitted at all. However, for high temperatures and long waves, within the scope of the Jeans-Rayleigh law, the new formula for *Ü* becomes the old formula.

Einstein [7] introduced the further assumption that in crystalline solid bodies the vibration energy U of the oscillators is multiplied by 3 because of the three possible directions of vibration in space, to represent the total heat energy of the body. Nernst confirmed in connection with his new heat theorem in specific heat, and by experiment with his co-workers, not only this assumption, but extended this to fluid bodies [8]. However, the measurement of the specific heat provides no distinction between formulas 11) and 19), because upon differentiating U with respect to T the additive constant term $h\nu/2$ cancels. Thus, for now a direct experimental test of the new expression of U may not be possible. On the other hand, there are some other phenomena which I believe speak in favor of the hypothesis put forward here, that the absorption and the emission of radiant energy are two completely independent processes. Namely the absorption at any moment is determined by the energy incident in each case. The emission, on the other hand, occurs suddenly, spontaneously in certain quanta, at intervals that depend only on the state of the emitting structure, regardless of whether it is irradiated or not.

The remarkable observations of canal ray Doppler effect have already been discussed by quantum theory [9], but one can go further.

Since the temperature balance inside a body happens not only through radiation but also through heat conduction, it is reasonable to assume that not only when exchanging radiant heat, but also when exchanging the Energy of corpuscular movements, the emission according to certain energy quanta takes place. Therefore, for example, when an oscillator with the oscillation number ν is hit by electrons, it does not emit these electrons according to a kind of reflection law, but at a very specific speed independent of the speed at which they impact, which depends only on the frequency *v*, that depends only on the state of this energy or electric charge. [The above sentence was translated faithfully but its meaning is not clear. Using Planck's prior use of 'oscillators' as an energy in matter and not light, he may have meant a collision between electrons: when an electron oscillator of energy *hv* is hit by other electrons, the recoil electron will be emitted at a speed that depends only upon frequency *v*, and will not react like a reflection of particles.] Perhaps this explains why kinetic theory has this problem why "free" electrons of a metal do not make a noticeable contribution to the specific heat. For according to the view described here, the electrons have no independent degrees of freedom at all, since their speeds are completely determined. Individual electron movements are not considered. The distribution of the energy is from the entire metal over the various independent degrees of freedom. However, I would first like to express this conjecture with all reserve, especially with regard to the fact that Drude's theory is completely different, according to which the average electron energy is proportional to the absolute temperature, sometimes leading to remarkable agreement with experiment.

If the electron emission is caused by radiant energy, as in the photoelectric effect or when X-rays hit, then the speed of the electrons must only depend of the nature of the excited oscillator, not on the temperature and not on the intensity of the exciting radiation, which is generally determined by experiment, as has initially been quantitatively confirmed [10]. However, it must be noted that the wavelength of the exciting radiation does not immediately determine the frequency of the excited oscillators, as in luminescence phenomena.

The question of whether the energy of the emitted electrons arises from the incident radiation or from the emitting molecule is obvious from our standpoint, that the emitted energy always primarily arises from the energy of the oscillator, which in turn is conditioned by the energy absorption from the incident radiation.

Finally, it could be pointed out that the phenomena of radioactivity agrees with our hypothesis of “quantized emission.” One only needs to assume that the frequency of the oscillators, which have completely different kinds of emitted rays, occur completely independent of how those oscillations relate to temperature and specific heat of the radioactive substances. The way one atom has the ability to emit different frequencies at the same time, is generally explained by the preponderance of spectral lines, including those from phosphorescence spectra. The fact that alpha-rays from a given atom have a definite velocity and, as recent experiments seem to indicate, so do beta rays, are all in agreement with our quantum emission hypothesis [11].

The problem that absorption and emission of heat radiation, through the described hypothetical model, is by no means completely solved, but rather advanced because the application of the laws of chance always means renouncing a complete causal connection – the hypothesis of quantum emission seems to me for the time being not only suitable to resolve contradictions of the radiation theory with the most important foundations of Maxwell's electrodynamics, but also to highlight certain other phenomena that have not yet been properly understood. One will also wish to treat kinetic gas theory; we certainly do not want to reject it. We have barely given any account of the most interesting processes in a gas such as the collisions between two individuals molecules.

[1] M. Planck, *Verh. d. D. Phys.* Ges.2, 237, 1900; in altered form *Ann. d. Phys.* (4) 4, 553, 1901.

[2] H. A. Lorentz *Phys. ZS.* 11,1248, 1910.

[3] M. Planck, Ann. D. Phys. (4) 31, 758, 1910.

[4] M. Reinganum Phys. *ZS.* 10, 351, 1909.

[5] Small compared to the average time interval between two consecutive emissions.

[6] Fluctuations in the exciting radiation intensity, spatial and temporal, are present, but as a closer consideration shows, they have no influence here.

[7] A. Einstein, Ann. d. Phys. (4) 22-180, 1907.

[8] W. Nernst, meeting report. d. Prussian Acad. d. Wiss., pp. 247, 262, 1910.

[9] J. Stark, Phys. ZS. 9, 767, 1908.

[10] A. Einstein, Ann. d. Phys. (4) 17, 145, 1905; O. v. Baeyer and A. Gehrts, Verh. d. D. Phys. Ges. 12, 870, 1910; R. Pohl and P. Pringsheim, ibid.

[11] O. Hahn and L. Meitner, Phys. ZS. 10, 741, 948, 1909; O. v. Baeyer and O. Hahn, ibid. 11, 488, 1910.

Index of successful *Unquantum effect* tests

See www.thresholdmodel.com for links to pages in book *The Unquantum Effect*.

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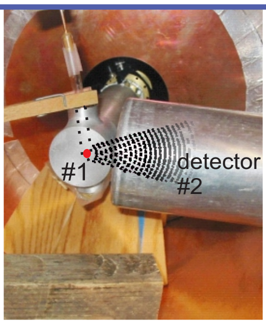
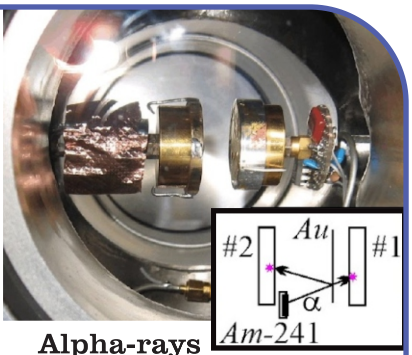
Theory



Gamma-rays



Alpha-rays

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