A CHALLENGE TO QUANTUM ENTANGLEMENT BY EXPERIMENT AND THEORY

Eric Stanley Reiter[1*]

ABSTRACT: It is argued on both experimental and theoretical grounds that quantum entanglement, which has been taken to explain consciousness, is an illusion.

KEYWORDS: Quantum Entanglement; Photons; Wave Particle Duality; Threshold Model; Consciousness.

Scientists intrigued by daunting phenomena such as consciousness have been turning to quantum mechanical (QM) entanglement. I call for fixing our fundamental physics before applying it to other fields. It is well known that Einstein and Schrödinger argued against QM. Schrödinger's scepticism is well documented:

> "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" **[1**, his 1952 Dublin Seminar**]**.

Schrödinger's works coining entanglement **[2]** and his cat **[3]** followed the so-called EPR paper **[4]**, and followed his discussion with Einstein on that paper. Therefore papers **[2, 3]** can be understood to say that the world-view delivered by QM is far too incomprehensible to take seriously. Arguments have raged. Most famously, entanglement is said to be upheld by so-called two-"particle" experiments performed by Aspect and team **[5]**. In such a test, a probabilistic wave-function spreads from a central point, then detectors on opposite sides can click in either of two states as read

1* eric@thresholdmodel.com, www.thresholdmodel.com. October 2016.

Now thinking of the gamma-ray unquantum effect, it being two-for-one implies energy had to be pre-loaded in either the detector or scatterer preceding the detection event, otherwise we violate energy conservation. We uphold energy conservation. Therefore we are forced to consider an accumulation hypothesis. The accumulation reaches a threshold, so here we call it the Threshold Model. We say we are violating particle-energy conservation. This is similar to the Bohr-Kramers-Slater **[11]** idea whereby energy conservation did not require particle-per-particle accounting. See **[9** or **12]** for how prior arguments on this issue were blundered. The accumulation idea is old and had several variants **[13, 14, 15]**. Most importantly, the idea of a pre-loaded state has been routinely ignored. In much search, I have not seen any writing treating a pre-loaded state since Millikan's book of 1947 **[16]**. A way to visualize the threshold model is by **figure 1**.

A few definitions are overdue. First, *particle* and *wave*. The important property of a particle is that a particle holds itself together. A particle can be anything from a dimensionless point to a galaxy. A wave does not hold itself together, and it spreads. That one distinction is all we need. For the definition of the photon, N Bohr paraphrases Einstein:

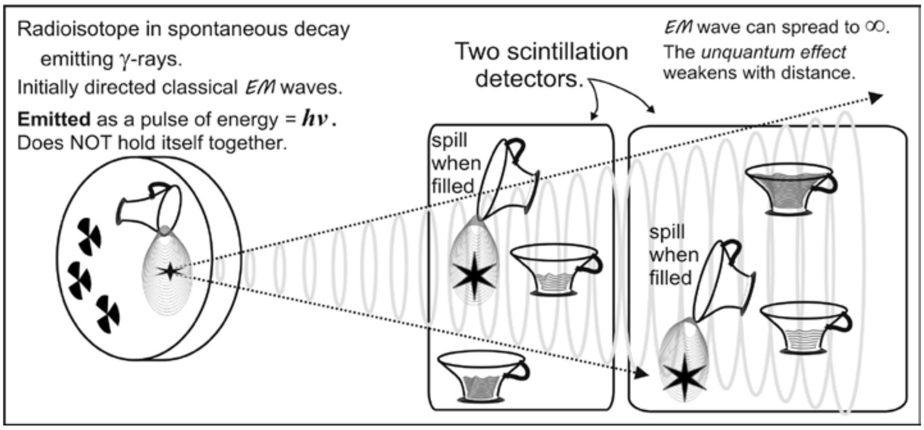


Figure 1. A way to visualize the threshold model in the gamma-ray test.

> "If a semireflecting mirror is placed in the way of a photon, leaving two possibilities for its direction of propagation, the photon would be recorded on one, and only one, of the two photographic plates situated at great distances in the two directions in question, or else we may, by replacing the plates by mirrors, observe these effects exhibiting an interference between the two reflected wave-trains **[17]**."

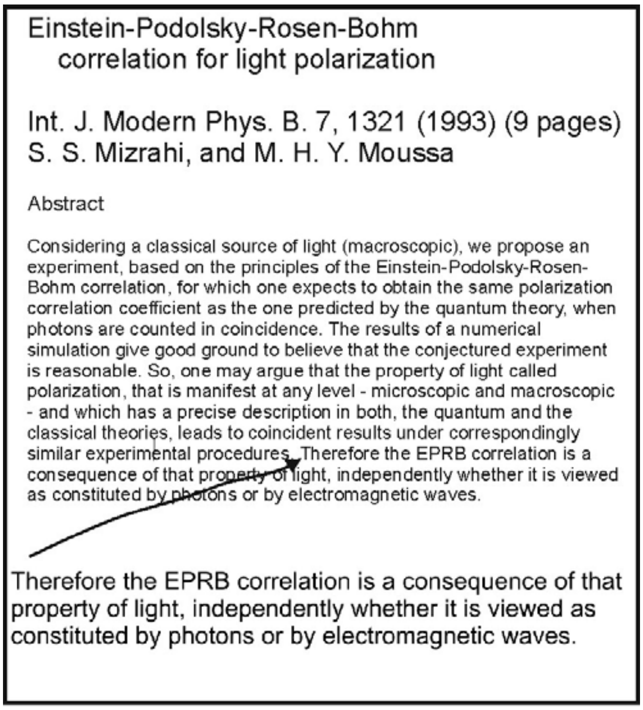
What about experiments reporting quantized charge? Measurements of e are performed upon ensembles of many atoms, such as in Millikan's oil drop experiment (and earlier by J. J. Thompson). Quantization as seen in an ensemble does not necessarily imply that free charge is quantized. From evidence of charge diffraction alone, it is a false assumption to think charge is always quantized at e. In our new model, if charge were to spread like a wave, maintain a fixed e/m ratio for any unit of volume, load-up upon absorption, and be detected at threshold e, it would remain consistent with conventional observation. An electron's worth of charge need not be spatially small. Chemists performing Electron Spin Resonance (ESR) measurements often model an electron as large as a benzene ring. A point-like electron would predict a smeared-out ESR spectrum. Carver Mead argued for an extended electron **[18]**.

The threshold model, supported by the unquantum effect, easily resolves the enigma of the double-slit experiment. A light-wave (or matter-wave) would load up, and show itself upon reaching a threshold with a click. The only conceptually difficult aspect of this theory is that there must be sufficient detail in a spreading matter-wave to encode for an identifiable element to load up upon absorption. This is not too difficult to imagine for elemental-waves (atoms), but we predict that complicated molecules will not load-up. Our alpha-ray test demonstrates how our threshold model applies to historical interference and diffraction tests with charge-waves (electrons), neutron matter-waves (neutrons), and elemental matter-waves (atoms) **[19, 20]**. Consistent with our threshold model is a recent helium diffraction experiment that revealed both particle and wave signatures in its diffraction pattern **[21]**. The matter-wave reads like a soliton that can either hold itself together in a particle state or spread like a wave. This is subtly different from complementarity, whereby the state depends on how one looks at the experiment.

RECENT EXPERIMENTS OF OTHERS

To challenge entanglement is to show that its key experiments are flawed. We examine two examples, two well known tests, one using light and one using matter.

Recall the popular work by Aspect and team **[5]** that convinced mainstream publishers that the world is ruled by spooky entanglement. They used an atomic beam stimulated by a laser to emit pairs of "photons." Clicks behind polarizers are reported



Einstein-Podolsky-Rosen-Bohm
correlation for light polarization

Int. J. Modern Phys. B. 7, 1321 (1993) (9 pages)
S. S. Mizrahi, and M. H. Y. Moussa

Abstract

Considering a classical source of light (macroscopic), we propose an experiment, based on the principles of the Einstein-Podolsky-Rosen-Bohm correlation, for which one expects to obtain the same polarization correlation coefficient as the one predicted by the quantum theory, when photons are counted in coincidence. The results of a numerical simulation give good ground to believe that the conjectured experiment is reasonable. So, one may argue that the property of light called polarization, that is manifest at any level - microscopic and macroscopic - and which has a precise description in both, the quantum and the classical theories, leads to coincident results under correspondingly similar experimental procedures. Therefore the EPRB correlation is a consequence of that property of light, independently whether it is viewed as constituted by photons or by electromagnetic waves.

Therefore the EPRB correlation is a consequence of that property of light, independently whether it is viewed as constituted by photons or by electromagnetic waves.

Figure 4. The experiment quoted in Kracklauer [23].

to correlate in a way that defies classical interpretation. They did not tell you that their laser delivers polarized light. The atoms in the beam are known to emit in a two-$h\nu$ cascade. Therefore, we expect emission to be in polarization-correlated $h\nu$ pairs. We claim our $h\nu$ is emitted in an initially-quantized directed burst, but thereafter this energy will spread classically. Their data is in **figure 2**. This graph is expected from Malus's law and classical polarized light as a function of angle (nothing weird here). Indeed, other authors agree, see **figures 3 and 4**.

An article in Nature received much attention for claiming that giant molecules, emitted one-at-a-time, will add up to a diffraction pattern **[24]**. It is a far stretch to imagine how such a thing can be true, by either QM or TM. We acknowledge that their diffraction roughly fits the de Broglie equation ($\lambda = d \sin \theta = h/mv$). It is more reasonable to expect these molecules are casting mere shadow patterns that are magnified by static electric fields. Electric field effects, the most obvious source of artefact, were not addressed. We have identified and posted four striking anomalies (see **Appendix III**) that require explanation: (1) there is insufficient velocity resolution in their model to prevent their fringe widths from being blurred-out to twice as wide, (2) fringe orders have the wrong relative intensities, (3) there is a large mismatch upon

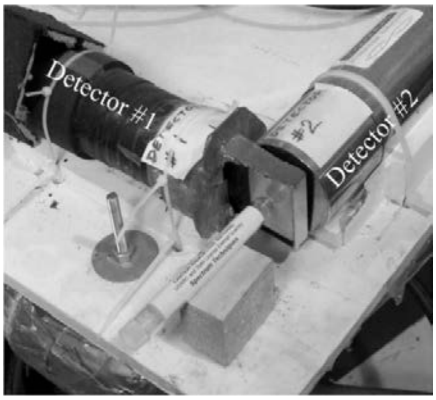


Figure 5. Two sodium iodide gamma-ray detectors in tandem geometry. Detector #1 is a custom-made 4 mm thick slab.

Poor collimator design has often delivered *chance*. The test was performed inside a lead shield lined with tin and copper; this lowered our singles background rate to 1/31. The coincidence background rate remained a significant fraction that must be subtracted.

Referring to **figure 6**, components for each of the two detector channels are an Ortec 471 amplifier, an Ortec 551 SCA, and an HP 5334 counter for singles rates (not shown). A four channel LeCroy LT264 digital storage oscilloscope (DSO) with histogram software, monitored the analog pulses from each amplifier on DSO channels (1) and (2). DSO also monitored SCA timing pulses at channels (3) and (4). The stored image of each triggered pulse shows well-behaved pulses to assure that noise and pulse-overlap were not a factor. This DSO can update pulse-heights, (A)(B), and time-difference Δt (C) histograms after each "qualified"-triggered sweep. To assure exceeding *particle-energy conservation*, LL on each SCA window was set to at least 2/3 of the ^{109}Cd 88 keV gamma characteristic pulse-height.

A coincidence background test with no source present had 304 counts/49.4ks = 0.00615/s, a rate to be subtracted. Within the same time-window τ, taken as 200 ns, the chance rate from Eq. 1 was R_c = (8.21/s)(269/s)(200 ns) = 0.000442/s. The experimental coincidence rate within τ was R_e = (101/4.59ks) – (0.00615/s) = 0.0158/s. The unquantum effect was R_e/R_c = 0.0158/0.000442 = 35.7 times greater than chance.

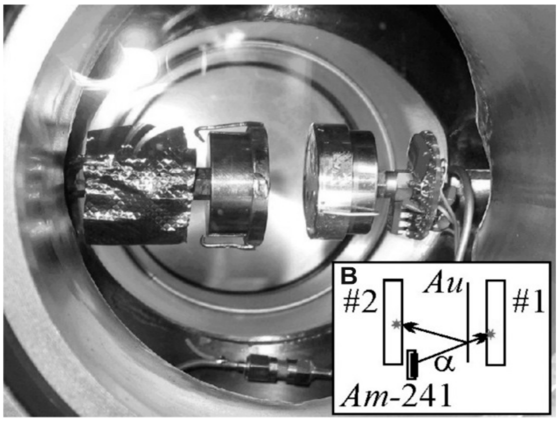


Figure 7. Alpha-ray experiment.

Data of **figure 8-a** was a two-hour true-coincidence control test with the two detectors at right angles to each other and with the ^{241}Am centrally located. Only the chance rate was measured, assuring that only one alpha was emitted at a time. 4π solid angle capture was not attempted because it requires a specially made thin source. However, the right angle arrangement is adequate, and it is well known how ^{241}Am decays. Any sign of a peak is a quick way to see if chance is exceeded. A background coincidence test of 48 hours with no source present gave a zero count.

Data of **figure 8-b** taken Nov. 13, 2006 was from the arrangement of **figure 7**

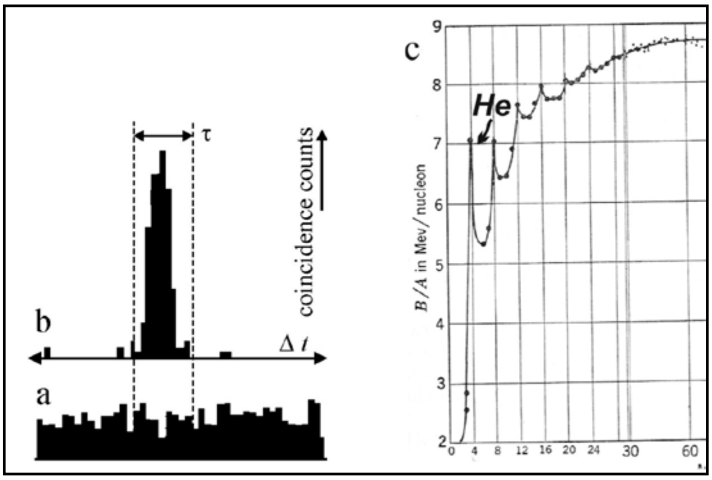


Figure 8. a: true-coincidence histogram. **b**: beam-split coincidence histogram. **c**: binding-energy per nucleon **[25]**.

APPENDIX III

On, 22.05.2012, 01:54, Eric Reiter wrote:

Dear Dr Juffmann

Regarding your recent article, “Real-time single-molecule imaging of quantum interference,” I have performed calculations on your data that do not make sense to me.

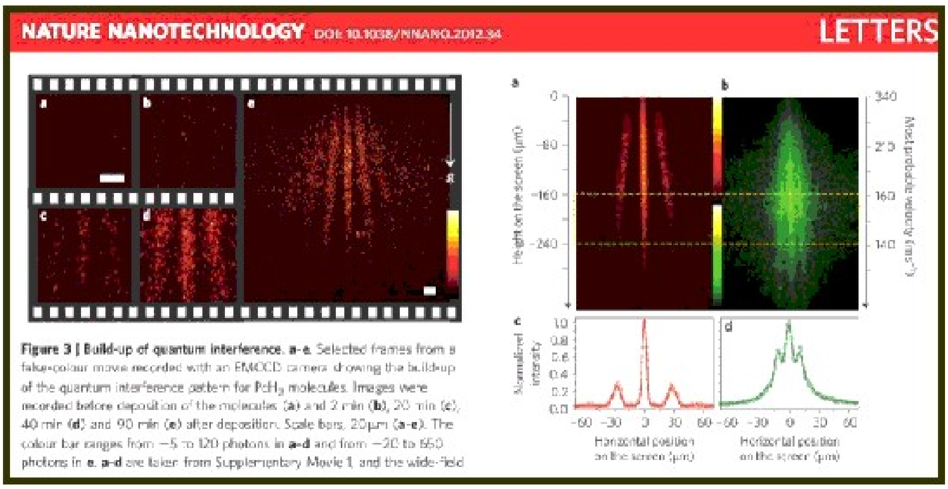
1) Let’s calculate the fall of a particle. We can use (1/2)gt^2, where t = time = distance/velocity. For a fast particle Hfast = (9.8/2)(2m/340m/s)^2 = 169×10^-6 meters. For a slow particle Hslow = (9.8/2)(2m/140m/s)^2= 1×10^-3 meters. Hslow – Hfast = 830 micrometers. But you show only 240 micrometers. Therefore the difference in falls should be 3.4 times larger than you show.

2) I used a multiple slit diffraction simulation tool to test what the intensity profiles should be. I found your first order fringes were a few times brighter than they should be for the given wavelength/slit-width and wavelength/slit-spacing ratios. The tool I used is http://wyant.optics.arizona.edu/multipleSlits/multipleSlits.htm.

Though this tool has fewer slits than yours, I found this did not change the intensity ratios.

3) Given the dimensions of your instrument, the velocity resolution should cover 0.43 of the sensor plane by the following calculation: The slit height is 100 micrometers, and the projection to the sensor plane should make this 2/(2 – 0.56) larger, that is 138 micrometers at the sensor plane. But the sensor plane is 320 micrometers high. Since 138/320 = 0.43, a particle of any given velocity could land anywhere in a vertical segment of height that is 0.43 of the screen height. So the first order fringes should have been very noticeably widened as the fringes descend, by this apparently poor velocity resolution.

4) In the published movies of the detector plane, the intensity profiles of the fringes have edges that seem to rise and fall too abruptly. Also, the intensity profile of each fringe, especially the central fringe, in the movie looks flat. Fringes should have peak-like



[7] Knoll G., [Radiation Detection and Measurement], (1979). Also, for the chance equation see Melissinos, [Experiments in Modern Physics] (1966) Pg 407.

[8] Reiter, E., "New Experiments call for a Continuous Absorption Alternative to the Photon Model," Proceedings of the SPIE 2015 What are Photons?, available on http://www.thresholdmodel.com.

[9] Reiter, E., "Photon Violation Spectroscopy," available on http://www.thresholdmodel.com.

[10] Reiter, E., "Particle Violation Spectroscopy," available on http://www.thresholdmodel.com.

[11] N. Bohr, H. A. Kramers, J. C. Slater, "The Quantum Theory of Radiation", in Sources of Quantum Mechanics, B. L. Van Der Waerden, ed. (Dover, New York, 1967); Phil. Mag. 47, 785 (1924); Zeits. f. Phys. 24, 69 (1924).

[12] Reiter, E, "An Understanding of the Particle-Like Property of Light and Charge," available on http://www.thresholdmodel.com.

[13] Kuhn T. S., [Black-Body Theory and the Quantum Discontinuity 1894–1912], Oxford University Press, 235-264 (1978).

[14] Whittaker E., [History of Theories of Aether and Electricity 1900-1926], 103 (1953).

[15] Wheaton B. R., [The Tiger and the Shark] (1983).

[16] Millikan R.A., [Electrons (+ and –) Protons Photons Neutrons Mesotrons and Cosmic Rays], University of Chicago Press, revised edition, 253 (1947).

[17] Bohr N., [Atomic Physics and Human Knowledge], John Wiley and Sons Inc, New York, pg 50-51 (1958).

[18] Carver Mead SPIE keynote talk 2013, http://natureoflight.org/?mpage=conf&spage=conf-2013#keynote

[19] Estermann I., Frisch R., Stern O., "Monochromasierung der de Broglie-Wellen von Molekularstrahlen," Zeitschrift fur Physik, A73, 348-365 (1932).

[20] Berman P. R., [Atom Interferometry], Academic Press (1997).

[21] Doak R. et al, "Towards realization of an atomic de Broglie microscope: helium atom focusing using Fresnel zone plates," Phys. Rev. Letters, 83 (21), 4229-4232 (1999).

[22] Kracklauer A. F., "What are Photons," Proc. of SPIE vol 9570 (2015). Available at www.nonloco.com

[23] Mizrahi S. S, Moussa H. Y., "Einstein-Rosen-Pedolsky-Bohm Correlation for Light Polarization," Intl J Modern Physics B, pg 1321 (1993).