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A symmetry hidden at the center of quantum mathematics causes a disconnect between quantum math and quantum mechanics

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ABSTRACT

Although quantum mathematics is the most successful science ever, that does not mean we live in the universe described by quantum mechanics. This article is entirely based on symmetry. Two symmetrical universes could have exactly the same mathematics, but differ in other respects. The motivation for seeking symmetry inside quantum mathematics is that the QM picture of nature is bizarre. Richard Feynman says no one can understand it. We propose that the quantum world is not bizarre. QM portrays the wrong universe: the symmetrical one, not the one we inhabit. If quantum waves travel in the opposite direction as what is expected, then we would have the same math but a different universe, one that is recognizable and familiar. Wave equations are symmetrical with respect to time reversal. This means they are symmetrical with respect to wave direction reversal (with time going forwards). This wave equation symmetry is the basis of the symmetry of two models of the universe, only one of which is congruent with the universe we inhabit.

Indexing terms/Keywords

Elementary Wave Theory, TEW, EWT, wave equations, symmetrical mathematical models, Lewis E. Little

Academic Discipline And Sub-Disciplines

Physics, Quantum Physics, Foundations of quantum mechanics

SUBJECT CLASSIFICATION

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TYPE (METHOD/APPROACH)

This is the fifth in a series of articles on a paradigm shift in mathematical physics caused by Elementary Wave Theory (EWT). Is there symmetry in quantum mathematics? Wave equations are symmetrical with respect to the direction of the waves. Therefore quantum math, the most successful science ever, is compatible with two different pictures of nature, depending on which direction the waves are thought to travel. Although these two pictures of the universe are identical mathematically, they differ in other respects. For example the QM picture of nature cannot be understood by the human mind. The Elementary Wave picture can.

PART 1. Introduction

Two universes can be symmetrical to the point that they have the same mathematics. An example is a universe reflected through the origin. If only one of the two could correspond to the nature we inhabit, which one would it be?

1.1 The story of two universes

If we say that quantum math is the most powerful science ever (which it is), there is another step before we are justified in saying that quantum mechanics must be true. The missing step is to prove that quantum mechanics is the only possible universe corresponding to quantum mathematics. If it could be shown that there is another universe corresponding to quantum math, that possibility would destroy the strongest argument that QM is true.

This article proposes that there is a second universe, different than QM. This rogue theory, called Elementary Wave Theory (EWT), is a fringe theory that could be viewed as a crackpot idea or as a paradigm shift of tectonic proportions. Even though EWT is ignored by leading physicists, even though it is denounced as "not science", its mere existence demolishes the logic which says that quantum math and quantum mechanics are the same thing. It is equally logical to say that quantum math and EWT are the same thing, whereas the QM universe is an illusion that does not exist. [2-13]

What evidence would suggest that the QM universe doesn't exist? The QM picture of the quantum world is full of contradictions (such as Schrödinger's cat, or the multiple absurdities arising from wave function collapse). Richard Feynman says that no one can understand the QM picture of nature. No one disagrees with Feynman. The only known solution is the Copenhagen interpretation, which says, "Shut up and do the math." In other words, if you focus on quantum math then you are on solid ground, because the universe portrayed by QM is like a bad dream.

1.2 "Time reversal" implies "wave direction reversal"

Inside quantum mathematics where can we find a symmetry that is so pivotal that it might be the basis upon which we could build a symmetrical universe? It is well known that wave equations have time reversal symmetry. John Wheeler and Richard Feynman wrote a famous article in 1945 proposing that it explains radiation.[1] Throughout his life, Feynman was

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amused, playing around with the idea of time reversal symmetry. But we are not proposing to build a symmetrical universe that goes backwards in time. There is a different implication of time reversal symmetry that Feynman never considered.

What does the term “time reversal” mean? There is no time operator in QM. Time is a parameter, not an operator. Therefore there is no “time reversal operator.” To speak of “time reversal” is covertly to speak of waves travelling in the opposite direction, with time going forwards in the conventional direction. The pivotal symmetry that we seek is that wave equations are wave direction symmetrical, with time always going forwards as a parameter. That last sentence is the most important sentence in this article.

1.3 If Elementary Waves are fanciful, QM is also fanciful

Such a proposal sounds preposterous to many readers. It raises many problems, such as how to understand the flow of energy, or how to understand wave-particle duality experiments. This article will sketch a comprehensive picture of how such a symmetrical universe might operate. We will not attempt to prove any details. Rather we will attend to the big picture, a panoramic painting of everything in the universe. Until we provide such a comprehensive picture, no one would imagine what we are talking about.

Many readers will scoff, saying, “that is not mathematics, rather it is a fairy tale!” We propose that before you can build a mathematics you need a system of meaning. You need to establish a series of assumptions and presuppositions that form the intellectual context for building a mathematics. We don’t need a new mathematics -- we already have quantum mathematics. What we are attempting to do is to change the foundation upon which quantum math rests. We are jacking up the house, tearing out the old foundation and constructing a new hi-tech concrete foundation with steel rebars and good drainage. Then the house can be lowered to rest on a better foundation.

We are about to launch off into a parallel universe. Leading experts accuse us of writing fiction. We reply, “If we are writing fiction, what about the tall tales that QM has fabricated during the last century?”

Are you so content with nature as described by QM that you can say that QM is not far fetched? Are you comfortable with the idea that particles on the other side of the galaxy can affect conditions in your life by nonlocal influences that are instantaneous across 100,000 light years? Are you willing to say that Schrödiner’s cat is believable, or that cause and effect can be reversed in time, so that the effect precedes the cause? Are you comfortable with wave function collapse in all of its absurdities? Do you say that it is not far fetched that a particle can be nowhere in specific, smeared out widely as a probability density, and then abruptly collapse at a speed greater than the speed of light, so that it becomes a point particle as it strikes a detector?

Even if you know nothing of EWT, the universe described by QM sounds phony. Is it not strange to speak of “quantum weirdness” as if you were describing something about nature, as opposed to describing evidence that you made a mistake in your starting assumptions?

Neither QM nor EWT is more far-fetched than the other. It is true that QM is a dominant system that has all the money, prestige, power and attention. EWT is so new that it has trouble getting any attention, and therefore it sounds peculiar and unfamiliar. But mathematicians have never cared about such issues. From the viewpoint of mathematics the question is this: which fairy tale is more self-coherent and plausible as corresponding to the universe we inhabit?

1.4 How to respond to an argument

Imagine a conversation in which someone says, “QM must be true, because quantum mathematics is the most successful science ever.”

You might respond, “You can only make that assertion if you have proved that EWT is false!”

The other person replies, “I never heard of EWT.”

You say, “Whether you heard of it or not, you cannot claim that QM is true unless you first disprove EWT.”

The other person says, “I don’t know what you are talking about!”

1.5 Syllogism

Supposing you know that

1. If A is true then either B or C is true.
2. If B is true then C is false.
3. if C is true then B is false.

Knowing this, you open any textbook of quantum mechanics and read in the first paragraph: “Because A is true, therefore B is true.” Do you see anything wrong?

1.6 Vocabulary we will use in this article

Another way to say the same thing is that there are two universes that correspond to quantum mathematics. One is the bizarre universe that quantum textbooks tell us about. The other is the universe we are about to describe.

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A background assumption of this article is that there are three domains of language. The first domain is quantum mathematics, which contains symbols such as the Schrôdinger and Dirac equations:

$$H|\psi\rangle = i\hbar\frac{\partial}{\partial t}|\psi\rangle$$

and

$$i\hbar\gamma^{\mu}\partial_{\mu} = mc\psi.$$

The second domain is what we will call "QM belief systems." This contains ideas such as: "wave-function collapse occurs when an observation is made," or "waves and particles form wave-particles."

The third domain is what we will call "Elementary Wave (EW) belief systems." This contains ideas such as "wave-function collapse occurs when a particle is emitted," or "particles follow waves backwards."

It is almost universally believed that quantum mathematics and quantum mechanics are synonyms. In other words, it is believed that the triumph of domain one means that domain two must be true. However, this article proposes that domain one is also compatible with domain three. We claim that empirical evidence favors domain three over domain two as a picture of nature. We propose to uncouple quantum math from QM belief systems, and connect it instead to EW belief systems. That explains the subtitle of this article: "A disconnect between quantum math and quantum mechanics."

PART 2. How can waves go "backwards"?

Although time reversal is a well-known idea in physics, wave direction reversal is not. Furthermore it appears to contradict some well-established principles, such as the idea that all waves carry energy, or the experiments proving wave particle duality. It requires hard work to understand the EW belief systems. EW contains several counter-intuitive ideas.

We will elaborate some of the core EWT belief systems, without attempting to prove any of them.

2.1 Energy flows in the opposite direction as waves

Not all equations in physics have time reversal symmetry. Those equations that describe a loss of energy (or increase in entropy) are not time reversible. How does EWT deal with this problem?

The waves that travel in the opposite direction as particles convey zero energy. In the next paragraph we will address the problem that many physicists believe that a zero energy wave is a contradiction in terms. Particles carry all the momentum and angular momentum in EWT, and particles continue to travel in the expected direction: from particle source to target. Thus energy flow and entropy behave as expected. Therefore EWT does not have problems due to entropy.

For many physicists the primary stumbling block preventing them from understanding EWT is the idea of zero energy elementary waves. Physicists have a contradiction embedded in their brain. One is the idea that all waves carry energy, indeed energy is what defines a wave. The other is that quantum wave equations carry probability densities, not energy. Probability amplitudes can flow like a current or flux. It is not clear why so many physicists fail to recognize that they believe two contradictory ideas: ALL waves carry energy, but quantum waves don't.

2.2 Core beliefs of Elementary Wave Theory

EW Theory starts with the idea that waves and particles travel in opposite directions. Particles can only move by following a wave backwards (entangled particles are different). Everywhere in nature there are zero energy waves of all frequencies traveling in all directions at the speed of light. Because they carry no energy, we cannot detect such waves unless they are yoked to a particle, and then we can detect the particle. We are immersed in an invisible ocean of wave interference.

No one ever has, or ever will, directly observed an Elementary Wave. We base our science on inferences from the behavior of particles.

Why does a particle follow a wave? That's just the way nature is rigged up. No particle can ever move or exist without following an elementary wave. In any volume of space there are a finite number of particles (or a finite amount of momentum) but an infinite number of elementary waves (carrying no momentum). Most waves are not connected to a particle, but no particle ever exists without a wave. Sometimes a particle can "change horses" i.e. switch from one wave to another one.

Wave interference occurs BEFORE a particle connects to its wave. In other words, by the time a particle is emitted, all the probabilistic effects are finished, and the particle becomes a deterministic entity that follows its wave backwards (like a dog on a leash) to exactly that point on the target from which that wave is flowing. Before it is fired from a gun, the particle has many elementary waves impinging on it, and it chooses at random which ray to respond to, in proportion to the amplitude of the impinging ray.

Wave interference occurs much earlier in time and in a different location in EWT compared to QM. In a scattering experiment wave interference occurs in proximity to the particle gun. By contrast, in QM wave interference is located at the target long after the particle was fired.

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2.3 Timing wave-function collapse in the Schrödinger cat paradox

In the Schrödinger box, wave function collapse occurs long before the lid is opened. It occurs when a uranium atom decides to emit, or not emit, an alpha particle that then strikes a Geiger counter and triggers a hammer to fall and smash a tube of cyanide. All probabilistic effects are complete when the alpha particle is emitted in response to an elementary ray coming from the Geiger counter. The elementary rays are the vehicles that carry probability amplitudes.

Waves can be in a superposition, but particles are never in a superposition. Cats are never in a superposition.

2.4 The Boyd conjecture

The "Boyd conjecture" [6] is that these elementary waves are the physical analog of probability amplitudes. A probability amplitude is not just an abstraction in Hilbert space. It refers to something tangible in the physical world. In other articles we have proposed a way for reconciling infinite dimensional Hilbert space with three dimensional Cartesian space, so they merge.[5] They merge in a more intricate way than by tensor products of the Hilbert and Cartesian spaces.

Quantum math is a roadmap to the world of elementary waves. If we were able to see elementary waves, we would be seeing gears of quantum math in motion. The machinery described by QM textbooks would be visible right before our eyes. Unfortunately we are unable to see elementary rays. We have no direct way to detect them.

2.5 Wave-particle duality experiments

Wave particle duality experiments do not prove wave particle duality. Davisson and Germer for example proved that waves and particles interact, but their data can be explained by the electrons following waves backwards.[14-15] The waves come from the detector.[7,13]

We know of no wave particle duality experiments that control for the possibility that the waves travel in the opposite direction.

Furthermore there is at least one experiment that QM cannot explain, in which the only known explanation is that the waves travel from the detector to the neutron source. Kaiser, Clothier, Werner, et.al., showed in 1992 that interference inside a neutron interferometer can be restored if and only if an analyzer crystal is inserted in front of the C3 detector, outside and downstream from the interferometer.[16] The analyzer crystal could only affect interference if it were upstream from the interference. That implies that the neutron waves and the neutron particles travel in opposite directions. We have discussed this experiment at length elsewhere.[11]

2.3 Bi-rays

Entangled particles are different. There is another level of EWT, a more complicated model. Since we assume that everywhere in space there are elementary waves of all wavelengths travelling in all directions, it follows that every elementary ray has a mate, which is an exact copy of itself, travelling coaxially in the opposite direction. There are always two such rays of the same frequency traveling in diametrically opposite directions at the speed of light. We refer to the pair as a "bi-ray."

A pair of particles is called "entangled" if they are each following the same bi-ray in opposite directions. The probability of one particle following a bi-ray is the amplitude of it following one ray times the amplitude of it following the countervailing ray. From that last sentence flows all the mathematics of entanglement.

Entangled particles remain connected by their bi-ray, somewhat like an umbilical cord. It is not an instantaneous communication. Rather the bi-ray has certain characteristics that are present when the two particles are born. Flux flows in this bi-ray at light speed in both directions, but not at superluminal speeds, and not instantaneously.

2.4 Bell test experiments

In a Bell test experiment a pair of entangled particles is produced at a "source" (S) and the particles travel in opposite directions. According to Einstein, Podolsky and Rosen each particle carries certain hidden variables (such as its intrinsic spin) inside it. That EPR viewpoint has been proved wrong by Bell test experiments.

According to John Bell and QM neither particle has any characteristics until it is detected; the act of detection causes collapse of the wave function that instantaneously means that the other particle acquires the opposite characteristics (such as the opposite spin).

EWT offers a third possibility, at odds with both Einstein and QM. Wave function collapse occurs at the instant when both particles are born. They are born into and continue to follow a specific bi-ray. If you work out the math, this means that the probability of Alice's particle being observed at angle θ_1 and Bob's at angle θ_2 is $P = \sin^2(\theta_2 - \theta_1)$. These relationships are embedded in the bi-ray. They are not hidden variables inside the particles. They do not change when either particle is observed. The bi-ray intersects Alice's detector, the source (S), and Bob's detector. It does not matter when Alice or Bob make their observations, the bi-ray still carries inside it the equation $P = \sin^2(\theta_2 - \theta_1)$.[2,4,13]

Thus when Alice observes her particle at angle θ_1, she can predict what is the probability that Bob will observe his at angle θ_2. Her act of observing sends no signal. Wave-function collapse occurs much earlier, when the particles were emitted, not when they are observed.[2,4,13]

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This way of thinking about the timing of wave-function collapse leads to skepticism about whether quantum computers or quantum communication schemes will be successful.

PART 3. Experimental data

Quantum orthodoxy proclaims that quantum mechanics has explained every experiment ever done. That is not true. There is at least one experiment that QM has been unable to explain (see Kaiser above), and a bunch of other experiments (such as the double slit experiment) that QM can only “explain” by embedding contradictions inside their explanation. The idea that a theory is wrong if an experiment comes up with negative results, is undermined by the habit of attributing negative results to “quantum weirdness,” and then incorporating that into your theory. If your theory ingests contradictions into itself, then no experiment can ever contradict that theory.

3.1 Why quantum experiments cannot refute quantum orthodoxy

Jacques, Wu, Grosshans et. al. conducted an interferometer experiment to determine how a starting assumption of wave-particle duality affects the sequence of cause and effect.[18-19] They were following an idea of John Wheeler’s. Their outcome data show that if wave-particle duality were true then time would have to go backwards: i.e. effect would precede cause. The logical conclusion is that wave-particle duality is false. Forty six thousand people have watched our YouTube video about the Jacques experiment (https://www.youtube.com/watch?v=E7Xjr-Cdu5M).

In quantum physics one’s belief system takes precedence over logic. Jacques et.al. concluded that YES, time does go backwards: effect precedes cause. In other words, the allegation that the quantum world is illogical justifies Jacques et al abandoning logic.

As a result of this culture in quantum physics, we can predict that no experimental data will ever contradict QM, because “quantum weirdness” can absorb any contradiction. This article proposes, controversially, that science differs from other belief systems in that scientific ideas can refuted by experimental data. If quantum mechanics cannot be refuted, then it is not science. It is an orthodox belief system. Science is limited to those theories that are refutable, which means that the quantum world cannot contain contradictions and still be studied by science.

Franco Selleri (1936–2013) was an Italian physicist who did not believe QM orthodoxy. He developed the idea of zero energy quantum waves that were present and interfering with one another whether or not particles were present. Experimental physicists would tell him, “Your ideas are very interesting Selleri, but I do not dare to conduct any of the experiments that you suggest. If our results contradict QM we would lose our reputation and our funding. If on the other hand our results agreed with QM we would be criticized for wasting money because everyone already knew QM was correct.”[17]

3.2 Experiments that have not yet been done

Elementary Wave Theory predicts exactly the same outcome as does QM in most experiments. In order to differentiate one theory from the other, you need a moving part. This part needs to move very fast, in nanoseconds. It is easy to design such experiments, but impossible to find any experimental physicist to conduct them. After one of my APS presentations Piotr Kolenderski, a Polish physicist, was in the audience. He asked if I had any experimental designs he could do. I gave him such an experimental design. Over the years he was too busy to conduct the experiment. In all the years since that, no experimental physicist has ever taken an interest in conducting an experiment to test EWT versus QM.

In a double slit experiment QM says that interference takes place near or at the target screen. EWT says the opposite: that interference takes place much earlier, at or near the particle gun, before a particle is emitted. We can exploit this difference to design an experiment for which QM and EWT predict different outcomes.

According to EWT, every point on the target screen emits elementary waves that travel through the two slits and interfere in proximity to the particle source. Because of that interference some elementary waves arrive at the gun with large amplitude (due to constructive interference), and others arrive with none (due to destructive interference). Based on the amplitude of the impinging rays, a particle will at random choose one specific wave to follow backwards with a probability of one to that exact point on the target screen from which that ray is emanating. It doesn’t matter which slit is used. There is no wave interference after the particle leaves the gun.

How can this be used to design an experiment?

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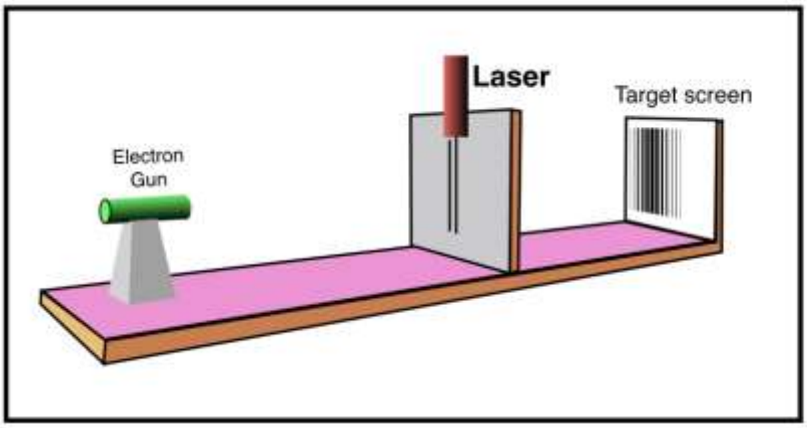

Figure 1: Design of a double experiment for which QM and EWT predict different outcomes. Electrons are fired one at a time, followed by a pause. If the laser blocks the right hand slit starting one nanosecond before or after an electron is fired, the Elementary Wave Theory predicts this unusual pattern would appear on the target screen.[3]

If a powerful laser were located above the right slit (Figure one), pointing down so its beam would block the slit, and if the laser could switch on within a nanosecond of the emission of a particle, then that laser would close the slit so no particle could travel from the gun to the target screen. QM predicts there would be only one vertical line on the target screen, caused by particles traveling through the left slit. EWT predicts a different picture on the target screen, as shown in the Figure. There would be half of an interference pattern displayed on the target screen, because when both slits were open (prior to the laser firing) elementary rays would come through both slits and cause wave interference at the particle gun. The particles would then follow rays backwards, but the right hand side of the interference fringe pattern would be obstructed because the right slit is now closed.

There are other experiments that can easily be designed for double slit experiments and for Stern-Gerlach magnet experiments, in which QM and EWT predict different outcomes. The problem is not designing such experiments. The problem is finding a physicist with the courage to conduct such an experiment that endangers the physicist's career. Needless to say funding sources would never make money available for such an experiment.[3]

PART 4. Darwinian evolution

If humans cannot picture and understand the quantum world (except through mathematics) then either we have made a mistake in our starting assumptions, or the quantum world is intrinsically not understandable. Quantum experts assert the latter. They say we cannot understand the quantum world because our thinking is based on our experience in the classical world.

This is an astonishing statement from the viewpoint of evolution and neuro-cognitive sciences. If humans are intrinsically unable to understand something, that would have profound implications for our understanding of the evolution of the human brain.

4.1 Why does the human species exist?

Why do humans exist, from an evolutionary point of view? Why didn't homo sapiens become extinct millions of years ago? With one exception we do not have the characteristics needed for survival. We cannot see well, cannot fly or run very fast. We have a poor sense of smell compared to dogs, and we lack the electrostatic sensory organs of fish. There is one thing at which we excel, and that is the sole explanation of our survival.

We excel at figuring things out. We have figured out things that we don't immediately see or experience, even when that thing is counter-intuitive. We can figure out how a hostile other tribe is thinking. We can figure out animal behavior before it happens. We can predict when there is going to be a famine. We can figure out a vast number of things that have nothing to do with our immediate experience, even illogical things, and for that reason we have been able to survive and multiply.

If we exist because we have figured out a zillion things of which we have no direct experience, why would it be that the ONLY thing we have been unable to figure out is how the quantum world looks and how it works? Physicists glibly tell us that it is because our only experience is with the classical world. Yet the defining characteristic of homo sapiens sapiens is our ability to figure out things of which we have no direct experience. If humans could only understand what we experience in the classical world around us, then we wouldn't exist.

Although leading physicists routinely make such startling statements about human evolution, they have failed to take the obvious next step: investigate why the quantum world is the ONLY unseen thing we cannot understand. How is the quantum world different from the zillion other illogical things which we have never directly experienced? How big is this deficit in our understanding?

The origin of life on earth is a counter-intuitive event that has nothing to do with our experience in the classical world. We are making headway in figuring that out. How and why is the quantum world so different than the origin of life?

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If humans have an intrinsic inability to think about or understand one particular part of unseen reality, the neuroscientists need to map out the size and shape of that deficit in human cognition. If we are unable to make sense of the quantum world, what other parts of reality are we unable to make sense of? Where in the brain this deficit is located? Is it in the frontal lobe? Is there an evolutionary advantage to being stupid about only one thing in nature?

4.2 Sometimes words don't mean what they appear to mean

There is another way to decipher the statement, "we can't understand the quantum world because our experiences are based on the classical world." Perhaps we should not search for a meaning of the words, but look for what affect those words have on human behavior.

That statement means, "We have agreed that in order to join the quantum club you must agree to turn your brain 'OFF'." This is consistent with the Copenhagen Interpretation: "Shut up and do the math."

4.3 "We don't know"

There is one final conjecture of what the words might mean. Maybe that statement means, "We can't understand the quantum world, and we can't find any mistake we made in our starting assumptions after the greatest geniuses of all time have been searching for the mistake for a century, including Einstein."

Somehow my cousin, Lewis E. Little, did discover the error in about 1993. It took a long time for him to find any journal that was willing to publish his discovery.[20] Most journals rejected his article as "not science."

PART 5. Conclusions

There are two ways to convince a mathematician that it matters which theory (QM or EWT) is correct: the stratospheric and the practical approach. Mathematicians often have their heads in the clouds, so the first approach is to say that the clouds would be different if EWT were true, than if QM were true.

What is the evidence that Andrew Wiles's proof of Fermat's last theorem is true? It is logically self-consistent, and is coherent even when read by skeptics. That is the same proof that EWT is true and QM is false. We claim that EWT is coherent and logical, consistent with itself, and more compatible with experimental data than is QM. We are not as clever as Andrew Wiles, so we can't provide the details he provided.

Here is the practical approach: The war between QM and EWT is a conflict that affects budgets, careers, and decisions about who does and who does not get a Nobel Prize, or tenure. Take for example the science of quantum computing. The starting assumptions involve information carried by a particle when it is in a superposition, prior to wave function collapse caused by observing the particle.

The crucial issue is: When does wave function collapse occur? QM assumes it occurs when a particle is observed, whereas EWT says it occurs much earlier, when a particle is emitted. If EWT is true then a central assumption upon which quantum computer science is built, collapses. If you are a mathematician making a decision about whether or not your employer should invest a billion dollars in the race to build a quantum computer, shouldn't you at least listen to the EWT viewpoint first? Perhaps there are computer designs that are compatible with the theory of early wave-function collapse.

If you are developing a career in quantum computers, don't you think it would be wise to at least listen to what EWT has to say? EWT might be right or it might be wrong, but a wise mathematician would learn about the possibilities before investing decades in a career in computers based on logic that might be faulty.

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Author's biography with Photo

After getting his math degree from Brown University, then going to medical school and working a decade as a researcher at the National Institutes of Health, Dr. Boyd was Chairman of Behavioral Health at a Yale teaching hospital. He learned Elementary Wave theory (EWT) from his cousin Lewis E. Little who discovered it. Boyd is the primary spokesman for that theory, for the simple reason that he keeps on talking. He presented EWT a dozen times at conventions of the American Physical Society and published more than a dozen articles in peer-reviewed journals of Math and Physics. His You Tube videos (see Elementary Wave.com) are recognized as hilarious, intuitive and provide a clear window into the world of EWT. Those whose minds have been turned into a Möbius strip by quantum weirdness say Dr. Boyd cured them of their mental anguish.