ISSN 2347-3487
Volume 13 Number 3
Journal of Advances in Physics

Paul Dirac's view of the Theory of Elementary Waves

Jeffrey H. Boyd
Retired, 57 Woods Road, Bethany, CT 06524, USA
JeffreyHBoyd@gmail.com

ABSTRACT

Is science open to a new idea? Thomas Kuhn says paradigm shifts sound like gibberish to scientific leaders, and are rejected for that reason. The Theory of Elementary Waves (TEW) is such an idea: quantum particles follow waves moving in the opposite direction. Time always goes forwards. We focus on Paul Dirac's 1930 book *The Principles of Quantum Mechanics*, applied to TEW. We keep Dirac notation and quantum math but replace the picture of how nature is organized. Wave interference and probabilistic effects occur ***prior to*** particle emission. Wave function collapse occurs at emission & there is no further interference. We have launched a successful program of teaching this dissident physics in YouTube music videos of five minutes duration. Some of our videos have been watched 40,000 times: within YouTube search for "Jeffrey H Boyd TEW" to watch these amusing videos including one in which Yoda (from Star Wars) solves what Richard Feynman called the "Central Mystery of Quantum Mechanics." Another video asks whether the singer Adele is "real" given that the Bell test experiments have discredited local realism. A teenager is more likely to watch a music video than to read a scholarly physics article. Paradigm shifts occur when teenagers become enthusiastic, then grow up to become the next generation of scientific leaders.

Indexing terms/Keywords

Foundations of quantum mechanics, Wave particle duality, Theory of Elementary Waves, Teaching Physics, music videos, Katy Perry, Psy Gagnam style, Justin Bieber, Katy Swift, Wiz Khalifa, Marc Ronson uptown funk.

Academic Discipline And Sub-Disciplines

Physics, quantum physics, teaching physics, high school physics;

SUBJECT CLASSIFICATION

Library of Congress Classification #'s for Quantum Theory are from QC173.96 to QC174.52

for example: QC173.96 Quantum Mechanics Foundations

or QC174.12.Q36 Quantum theory

or QC174.2NT Wave Particle Duality

TYPE (METHOD/APPROACH)

This article is part of a paradigm shift that is so radical that most scientists refuse to hear it because they say it is unintelligible nonsense. Alfred Wegner suffered that same fate when he proposed in 1912 that continents have been drifting apart after Pangea broke up. Thomas Kuhn warns rejection is the fate of paradigm shifts. Franco Selleri says that the majority is rarely correct in science. In this article we propose that Paul Dirac's notation and linear algebra fits with a different picture of nature than the one assumed by Dirac. For example we reject wave particle duality, replacing it with the idea that particles follow waves backwards. Our approach preserves the elegance of quantum mathematics but gets rid of all quantum weirdness. Because we find that few physicists have any interest in TEW, we have begun to teach TEW on YouTube in the format of five minute music videos. At the end of this article we discuss this novel approach to teaching physics to high school and college students. Some of our videos have been watched 40,000 times.

INTRODUCTION

TEW is a fertile new theory, as we will show (1-6). The problem is that readers can only understand it if they are open to a drastic paradigm shift. Thomas Kuhn says that it is unusual for a paradigm shift to be welcome by the leaders of science.(7) Alfred Wegener's 1912 ideas about Pangea and "continental drift" were rejected as nonsense and mentioned in no scientific textbooks. Wegner's idea was not taught in geology classes. His idea was the origin of plate tectonics. Whether science is open to TEW as new idea is an unanswered question. Historically usually the leading scientists have rejected radical new ideas, and it is only when teenagers take up the banner of change, then mature to become the next generation of scientific leaders, that a paradigm shift occurs.

It is easy to show that experiments only "prove wave particle duality" if you start with the prior assumption that waves and particles travel in the same direction. If you assume they travel in opposite directions, those experiments prove nothing (6, 8). There is not room to explore that observation in this article.

1. Superposition

We will focus on the first chapter of Paul Dirac's book *The Principles of Quantum Mechanics*(9), which concerns the "principle of superposition." The point that will emerge after we translate Dirac into a TEW framework, is that waves, not particles that are in a superposition. Wave function collapse occurs at the time of particle emission, after which the particle has a definite position, polarization, and momentum that does not change. This does not mean that TEW is deterministic, for the uncertainty principle and all the probabilistic features of QM such as wave interference are embedded in the waves (or rays). In other words, experiments will almost always find the same results with TEW as with QM. Only in very specialized experiments (2,3) (not discussed in this article) do the two theories predict divergent outcomes.

Dirac's first example of superposition (pages 4-7) is that a plane polarized photon whose angle of polarization is oblique impinges on a tourmaline crystal, "which has the property of letting through only light plane polarized perpendicular to its optic axis." Dirac says the wave particle approaches the crystal in a superposition that collapses inside the crystal so that downstream there emerges either a whole photon polarized perpendicular to the optic axis, or no photon. If the original plane of polarization had angle ϕ to the horizontal, then the proportion of the particles emerging at the back end of the crystal will be sin(ϕ). Dirac assumes without discussion that waves and particles travel in the same direction, as wave-particles.

According to TEW elementary rays impinge on the particle source, and a particle will choose one of them at random to follow backwards. The amplitude that the particle will be triggered by a given ray is proportional to the amplitude of that ray. If we think of the incident rays as having horizontally and vertically polarized aspects, a photon will at random follow one or the other, in proportion to cos(ϕ) and sin(ϕ). However, only the vertically polarized elementary rays have originated at the detector. Horizontally polarized elementary rays are unable to penetrate the tourmaline (traveling from the detector toward the source). Therefore those photons at the source which randomly chose to follow (backwards) the vertically polarized incident ray will be the only ones to arrive at the detector. Those which, upon emission, selected horizontal polarization, will be stopped at the crystal because their wave ceased to exist inside the crystal.

Dirac's second example (pages 7-10) is an interferometer which forces a photon to travel in one direction or the other, with the two paths crossing each other so there is wave interference. He paints a picture of each photon interfering only with itself when the paths cross. According to TEW elementary rays start at the detector, and bifurcate at the point of interference, so that the waves are in superposition, one traveling one path and the other traveling the other way through the interferometer. At the photon source the elementary rays converge and interfere. Each photon makes a random decision which of these two incident rays to follow backwards. The particle is not in a superposition after emission, nor is there any interference. When it is detected the detector finds an interference pattern, because that pattern was embedded in the waves as they traversed the interferometer previously.

Critics say there is no way to picture Dirac's superposition of one photon taking two different routes simultaneously (p. 10). Dirac replies that the important thing in science is to have a mathematical model that accurately predicts experimental outcomes: the picture is not essential. The advantage of merging TEW and QM, as I recommend, is that you get the best of both worlds. You continue to have the powerful mathematics of quantum amplitudes, but you also have a picture, in which "amplitudes" and "elementary rays" are two names for the same thing. Probability amplitudes travel in space in the direction opposite that of the particle, but always forwards in time. Time is never reversed.

Elementary rays have two features. It has an amplitude $|A|e^{i\theta}$. That amplitude travels through space, for example from a detector towards a particle source. Quantum amplitudes are not just an abstraction in mathematics. They describe something in the physical world. It is easy to show that these amplitudes inhabit a Hilbert space (6), but we don't have room to explore that idea in this article. It is easy to show that they convey zero energy. Although physicists often say that ALL waves convey energy, that energy is allegedly the very essence of every wave, they also say that quantum equations convey amplitudes and not energy. Therefore physics acknowledges the existence of zero energy waves, although the physics picture has the waves traveling in the wrong direction.

2. Wave particles

The sketch of TEW provided above involves energy and mass because photons are following the elementary rays backwards. We need to introduce new notation. Let Æ be the symbol for an elementary ray without a particle, and let ∏ be the name of a particle without an elementary ray. A fact of nature is that there are an infinite number of rays but a finite number of particles. So there are Æ's without particles, but every particle ∏ is always attached to one Æ or another. Particles can sometimes jump from one Æ to another.

For a system consisting of a single particle we will define a wave particle ψ as Æ + ∏. Our wave particle is almost identical to that of quantum mechanics, except that the direction of the wave implies an intimate connection between the wave-particle and the target toward which it is heading. Our instruments can see only wave particles. We cannot see waves Æ without particles. The only information we have about rays without a particle, is by inference.

The particle ∏ carries all the energy, and momentum. Other experiments suggest that polarization and spin are properties of elementary rays.

3. Dirac notation

This sets the stage for Dirac notation, which concerns wave particles. In pages 11-14 Dirac defines the "state" of a system: a description of the amplitudes of different superpositions of a particle. In TEW it would be the waves and not the particles that are in a "state" consisting of a combination of amplitudes, each with a particular weight in terms of likelihood. The probabilistic nature of quantum math is preserved in TEW. We affirm that that the probability of an outcome consists of the square of the absolute amplitude.

Each state of a dynamical system of waves corresponds to a ket vector. If the state consists of a superposition of other states, it can be expressed linearly in terms of the linear algebra of ket vectors. Dirac's elegant definition of kets and bras, their mathematical properties and their inter-relationship, is identical in TEW as in QM (pp. 11-22).

4. Double Slit Experiment, as an example

Take for example a double slit experiment. Let the amplitude for a particle arriving at the target screen be A + B, where these complex numbers represent whether the particle came through slit A or B. Now reverse your model. Every point on the target screen emits elementary waves that impinge on the particle source, where the amplitude is A + B. The probability of a particle being emitted in response to the impinging waves is proportional to the square of the amplitude: |A + B|. If you think of the point of origin of waves as moving up and down the target screen, the amplitude at the source will oscillate because of oscillating from positive to negative interference between A and B. Once triggered, a particle follows its ray with a probability of one, and will inevitably arrive at the target screen at precisely that point from which its elementary ray originated. After particle emission, there is no interference.

There is symmetry. The math and pattern on the target screen are identical with QM and TEW. One theory imagines interference is located only on the target side of the two-slit barrier; the other theory imagines interference is located only on the source side of the two-slit barrier.

Although the target screen continuously emits elementary rays of all frequencies, we can disregard 99.99% of them. The only ones worth considering have a frequency corresponding to the energy of the photon that will later be emitted: □ = E/h.

SUMMARY

In summary QM consists of two parts: formal mathematics, and ideas about what must be happening in the quantum world to explain the math. The former has enormous success and is the basis of our high tech economy. The latter is a disaster, but no one can figure out what is wrong with it. We propose to keep one and discard the other. We want to replace the picture with TEW.

Based on a decade of experience presenting this theory to physicists, it has become clear that most leaders of physics find these ideas to be ridiculous. Few journals (such as JAP) are open to new ideas. However high school and college students are very interested if they hear a new idea such as this. After a one hour lecture at a local high school two students were prepared to devote their lives forever to TEW. This author has embarked on teaching TEW systematically via YouTube, a venue that is more interesting to teenagers than scientific research journals. One of my YouTube videos has been viewed 40,000 times: that is a technical video focused on "Re-thinking a Wheeler delayed choice gedanken experiment." Because the target audience is teenagers, I have learned what they are interested in.

Two dozen YouTube music videos have each been viewed more than a billion times. I am currently re-working these music videos so that they teach TEW. In this process I have learned about copyright laws. If you want to see me dancing with Taylor Swift or adapting Yoda to teach TEW, you can find my YouTube videos by searching for "Jeffrey H Boyd TEW" inside YouTube. The TEW series has evolved into being shorter and shorter videos. Any video over five minutes will not be watched. It is necessary to amuse the viewer within ten seconds, or lose the viewer. I am posting a new YouTube video every month. This turns out to be an amusing way to teach physics and I get a hilarious response from viewers of all ages. Many of my friends are retired; they are amused by any music video that appeals to a teenage audience of one billion viewers.

Title and Authors

Paul Dirac's view of the Theory of Elementary Waves, Jeffrey H. Boyd, Retired,

57 Woods Road, Bethany, CT 06524, USA, JeffreyHBoyd@gmail.com

REFERENCES

1. Little, L. E., Theory of Elementary Waves, *Physics Essays* 9 (1), 100-134 (1996).
2. Boyd, J. H. "Re-thinking a delayed choice quantum eraser experiment: a simple baseball model," *Physics Essays*, March 2013, Vol. 26, No. 1, pp. 100-109, (doi: 10.4006/0836-1398-26.1.100).
3. Boyd, J. H. "Rethinking a Wheeler delayed choice gedanken experiment," *Physics Essays* 25, (3) pp. 390-396, 2012. (http://dx.doi.org/10.4006/0836-1398-25.3.390).
4. Boyd, J. H. "The Theory of Elementary Waves eliminates Wave Particle Duality," *Journal of Advances in Physics* **7** (3), 1916-1922 (Feb 2015). http://cirworld.org/journals/index.php/jap/article/view/228n.

5. Boyd, J. H. “A proposed physical analog of a quantum amplitude: Corkscrew model from the Theory of Elementary Waves (TEW)” *Journal of Advances in Physics* **10,** (3), 2774-2783 (Oct 2015). http://cirworld.org/journals/index.php/jap/article/view/5116.
6. Boyd, J. H. “A paradigm shift in mathematical physics, Part 1: The Theory of Elementary Waves (TEW),” *Journal of Advances in Mathematics* ***10*** (9), 3828-3839 (June 2015). http://cirworld.com/journals/index.php/jam/article/view/4719.
7. Kuhn, T. S., *The Structure of Scientific Revolutions,* (Chicago: U. of Chicago Press, 1996).
8. Boyd, J. H. "Re-thinking Alain Aspect's 1982 Bell test experiment with delayed choice," *Physics Essays*, 26 (4) 582-591 (2013).
9. Dirac, P.A.M., *The Principles of Quantum Mechanics,* (Clarendon Press, 1988).

Author’ biography with Photo

Dr. Boyd was born in 1943 in New Jersey, USA. He has been in dialogue with his cousin, Dr. Lewis E. Little, for over 50 years. Boyd’s undergraduate degree in mathematics was from Brown University. He has advanced degrees from Harvard, Yale and Case Western Reserve Universities, and served on the faculty of the National Institutes of Health for 7 years, and has been on the faculty of the Yale Medical School. His day job is as a psychiatrist, which is fortunate because he need not fear he is risking a career in physics by speaking in public about these controversial ideas. Boyd retired after a quarter century at Waterbury Hospital, Waterbury CT, a Yale teaching hospital. He has published in the New England Journal of Medicine, Journal of Advances in Mathematics and Physics Essays. He has given academic lectures on TEW at the American Physical Society more than a dozen times. Currently his study is arranged like a television studio with a green screen, and he spends his free time creatively redesigning YouTube music videos to teach his unique brand of physics. Slowly his obscure ideas are gaining popularity with his target audience: teenage geeks and nerds (the same kind of teenager as Boyd had been).