Tandem Piercer Experiment

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Abstract

This essay is based on the science project I am involved in as a duplicator of the nuclear physics experiment. The beam-split-like coincidence counting experiment with gamma-rays was invented by the American electrical engineer Eric Reiter in early 2000. The experiment, which I eventually started to call the Tandem Piercer Experiment, raises down-to-earth questions about the wave-particle duality, the early development of the atom model, the concept of a photon, and quantum mechanics. These questions are highly controversial in dissident science and brought me, as a layman, to the center of the sociological questions on how theories evolve in physics society and how science works. A lot of this controversy is dealt with polemically in the essay in conjunction with the overall description of the Tandem Piercer Experiment. I wish to present this authentic original work of Reiter as a delicate citizen science project. It is open to theoretical and philosophical speculation and calls for participation.

Keywords: photon, photoelectric effect, gamma-rays, wave-particle duality, quantum mechanics, coincidence counting, beam-split experiment, scintillators, semiclassical electron model, accumulation hypothesis, loading theory, citizen science, fundamental physics, demarcation problem

"It is the mark of an educated mind to be able to entertain a thought without accepting it."

- Aristotle[1]

Controversy over new ideas

We often hear that we have built the entire modern technological civilization based on quantum physics and the Standard Model of fundamental particles. But, how much of the technological advancement is a merit of heuristic engineering rather than theories in physics? All phrases that come with cliches and infinitely repeated punch lines in public, like "*quantum mechanics is the most precisely tested theory in the history of scienc*e," deserve a re-evaluation at times. Hypes and bubbles are common in our digital harvesting culture.

There is one problem. If someone were to doubt the mathematical effectiveness of quantum mechanics, like the German theoretical physicist Alexander Unzicker[2], NASA science researcher Alex Vary[3], or the independent Spanish scholar Oliver Consa[4], they would soon get most of the mainstream physicists and technocrats against them. There are so many new inventions like semiconductors, smartphones, lasers, global position systems (GPS), medical imaging (MRI), quantum computers, and new exotic forms of matter. Quantum and relativity theories[5] have become cornerstones of the most advanced and sophisticated achievements in science, symbols of the new era in human history that no other culture has accomplished before. Those theories have enabled so much that they should not be examined with wrong motives by wrong people, or they would be called heretics.

At the same time, quantum and relativity theories are so remote from the everyday conception that one needs to develop nearly absurd ways of acceptance mixed with strange mathematics, logical paradoxes, weirdness, unintuitiveness, and expertise in various experiments, real and made by thought.

If we rely on the scientific method's most guarded principle, namely criticism, even the greatest theories should be included in continuous evaluation and re-examination. I have not yet fully understood how the science community resolves the issue of embracing skepticism and, at the same time, treating individual critical thinkers as heretics. I've been a few times in a conversation where thousands of people in "The Worldwide List of Alternative Theories and Critics" collected by Jean de Climont have been blacklisted as crackpots.

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1 My favorite quote which is misattributed to Aristotle. The closest we can get to the quote is from Nicomachean Ethics, 1094b4: "for it is the mark of an educated mind to expect that amount of exactness in each kind which the nature of the particular subject admits." While the subjects in this essay are demanding, I do not want to bury the reader with the unnecessary depths of the formal mathematics behind the theories and technical details behind the experiments. That would require different types of publication. I want to take a minority side of the dissident and evaluate the theories of science covered in the essay from the angle of controversy with the conceptual level targeted to a dialog.

2 Alexander Unzicker: Bankrupting Physics - How Today's Top Scientists are Gambling Away Their Credibility, 2013.

3 Alex Vary: Critique of Physics Theory Inconsistencies, 2018.

4 Oliver Consa: Something is Rotten in the State of Quantum Electro Dynamics, 2020.

5 Please, see Appendix 1 to learn a short history and description of quantum mechanics and relativity.

Maybe that is due to resource handling. We try to be efficient in addressing only the new open problems that have good chances to be solved relatively quickly. But let us think of people who are not so much interested in building a career in science, making innovations for companies, or creating just new content. Let us propose for the duration of this essay that science is a way to pursue truth and ask specific questions about reality like why, how, when, what, from where, and to where.

In one of his interviews[6], Alexander Unzicker said that there are two possible ways to fail in scientific pursuit. When you question everything and when you doubt nothing. We have no time to verify every reference and source or derive everything all the time from the first principles. We need to start from some assumptions, somewhere in the middle, and see what kind of picture we can build. Further, if there are assumptions that we cannot confirm, study, and understand, they are probably not worth believing.

Looking for other appearances of puritanism in science, one might add competition between countries and the struggle for superiority between departments in the same university. Recently, I was listening to the World Science Festival conversation between Brian Greene and Nobel Laureate Brian Schmidt[7]. I found that there is a tough competition to be the first to discover and publish and a strong separation between being right and wrong in the field. That leads to unhealthy side effects in social co-work, but also misleading communication to the public. Eventually, I think this will lead to problems in the scientific method itself.

The central question is how to develop critical thinking and appreciate *a taken* world view instead of *a given*?[8] Something seems to be missing from the communication when we do it by old-fashioned “ask me anything when I am on a lecture stage” way. It is nice, it can inspire and accumulate the feeling of togetherness, but does it bring us closer to the truth? The sleek presentation should not take over the hermeneutic dialogue. One-to-one trusted conversation is the way to go if gaining ontic understanding with the epistemic one is the main concern of the seeker. I am not totally convinced that the elevator pitches work well in this pursuit.

Research is a long way from immature thoughts, incorrect assumptions, imperfect interpretations, fuzzy data, and over-simplified idealizations to slowly filter out things that do not work, correcting, iterating, bettering things that do not match. Often it is a path to learn new things at the same time. Brian Schmidt wished that people should instead seek cohesion than using their time to prejudice or postjudice who is right or wrong.

Suppose the discussion starts from the final results and the most recent news. In that case, no one realizes how it came to be; solving the problems, being wrong, hesitating, agonizing over, and doubting your reasoning to the point you think you have become crazy. There is already so much displeasing among researchers when they put something on the public table that anyone can analyze and falsify. It is very different from creating fantastic theories about cosmological origins, expanding spacetime metrics, dark forces, and parallel universes, all those sub-Planck scale theories that possibly cannot get any evidence of in our lifetime. We are fluid in talking about the scientific

[6] Conversations on Fundamental Physics: https://www.youtube.com/watch?v=Uo5MAhLpNu4

[7] Cosmology and the Accelerating Universe: https://www.youtube.com/watch?v=nO1eWxjQqaA

[8] See the concept of pregivenness by Edmund Husserl phenomenology: https://brill.com/view/journals/rip/50/1/article-p31_3.xml

method and empiricism, but at the same time, we fear simple experiments and workable theories because they are potential destructors of our ideas.

Modern physics is built on a vast and tight set of intervening principles and theories. If we change even a tiny part of the fundamentals, we probably need to re-analyze the whole system to see the consequences. We need to see if everything holds up in the bigger picture after modifying some current theory or using an alternative model.

The change need not to be enormous in equations after all. Sometimes we turn old words to mean something new and different, which may well lead to the most giant leap in understanding. This is, for example, what happened to the concept of time when it was tied to the geometric notation of spacetime in the Special Theory of Relativity. Einstein's 1905 paper "On the Electrodynamics of Moving Bodies" contained trivial algebra only, but shifting already parametrized time from the absolute background coordinate to the moving coordinate systems had radical implications in the conception of time[9].

Also, the concept of an atom changed its meaning from an original indivisible substance (Greek *atomos*) once it got split into smaller and smaller pieces starting from the hands of the cathode ray experimentalists in the 19th century. Scientists made the mistake of borrowing a metaphysical concept about the hidden substance of Leucippus and Democritus to a physical substance that scientists were improperly sure that it could not be split into smaller parts in the future.

The æther suffered by a similar take of scientists in the 18th century when it was used as the luminiferous æther, referring to some medium where light, magnetism, and gravitation would propagate. That is relatively far from the elemental æther spoken by ancient Greeks or quintessence spoken by medieval alchemists. And further it got when electromagnetism came first to work in, then to displace the æther. So, when we say that Einstein gave a death blow to the æther, we should at least know what æther he was, and we are referring to.

Words matter. In his later writings, Einstein suggested that his relativistic spacetime model for gravity in general relativity could be regarded as the æther, but no one bought that idea anymore. He was also sorry that philosophers misused the relativity concept and wished he could change its name to invariance theory. Laws are the same for all inertial frames of reference, the speed of light is constant for all observers, and spacetime is the all-existing geometrical framework where everything physical happens. That entails something absolute, stable, and permanent. But again, it was too late. People were already apt with the idea of relativity of everything. Words do really matter.

[9] Richard A. Muller: Now, the Physics of Time, Chapter 2 (2016).

Unquantum concept of Reiter

The Threshold Model that the American inventor and electrical engineer Eric Reiter proposes is about the fundamental interactions with electrons and combining the photoelectric effect equation $\boldsymbol{E} = \boldsymbol{h f}$ [10] with the de Broglie wave equation $\boldsymbol{\lambda} = h / \boldsymbol{mv}$[11]. The Threshold Model takes Planck's constant $\boldsymbol{h}$ as a maximum of action. Emission is quantized, but absorption is continuous and thresholded. We call it a semiclassical model where light is treated as a wave, and only matter is quantized.

The Threshold Model challenges the picture of reality if built upon the commonly accepted concept of the quantum jump and all spookiness caused by that. It is a small, kind of invisible change under the hood, but below the division line, the Threshold Model would significantly change the understanding of the fundamental interactions in an atom.

Another controversial thing is that the Threshold Model extends a long-ago proposed second theory of Max Planck which he debunked himself in 1923[12]. Similar approaches to the model of an atom were also called the accumulation hypothesis and the loading (or pre-loading) theory at that time. Reiter's approach is not totally new, but he asks, if the experiments were adequate, if precise enough details were taken into account, and if the trial was fair?

With the Threshold Model of Reiter, the old theory is lifted from the grave. But to be exact about Planck, he said that the resonator idea in his second theory had been disproved "*at least in its extreme form.*" Reiter's model is a modification of Planck's second theory, and thus taken to the perspective of that time in 1923, Planck might have thought differently about the Threshold Model, who knows.

One common criticism against Reiter's work is that "there must be something wrong in the experiment." In the Tandem Piercer Experiment, two scintillation detectors side by side measures a single beam of gamma, causing coincidental photoelectric effects, i.e. full-height pulses/clicks, in both detectors[13]. One might see these two statistically counted full-height pulses as a violation of energy conservation law. On the other hand, we do measure those two pulses, and it is a basic duty of the experimentalist to repeat and verify that there are no errors in the result.

To conserve energy for individual atomic processes, keep up with the conventional quantum theory, and have the double full-height pulse, there we have an unsolved dilemma. One suggestion is to look up the definition of energy conservation in Bohr-Kramers-Slater theory, where energy conservation was temporarily considered a more general statistical law[14]. In the wave-based Threshold Model, energy would be conserved in the same manner as a statistical law that allows two full-height pulses on two tandem detectors.

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[10] Energy **E** is Planck's constant **h** multiplied by frequency **f** (often written with Greek letter Nu **ν**).

[11] Wavelength λ (Greek letter Lambda) is Planck's constant **h** divided by momentum, which is mass **m** times velocity **v**.

[12] Helge S. Kragh, James M. Overduin: The Weight of the Vacuum, Chapter 3: Planck's Second Quantum Theory (page 17), 2014.

[13] Please, see Appendix 2 for the more details about the beam-split, the coincidence, and the tandem experiment. Exact details of the experiment you will find from Reiter's original works retrievable from his website https://www.unquantum.org/ and from the Reiter's publications mentioned in the bibliography of this essay.

[14] Helge S. Kragh: Bohr-Kramers-Slater Theory, 2009.

The quantum mechanical model cannot explain the result with the given constraints. Instant quantum jump in no time with the burst of energy packet in the electron emission process should release energy with not enough left for the second full-height pulse. Thus, Reiter provides the name Unquantum Effect for the mechanism of the experiment.

Sometimes it is regarded as a subtle issue only that the photoelectron emission and the quantum jump are in direct conflict in the Maxwell fields. Ashok Muthukrishnan writes with his collaborators in the revisited paper (2003) about the concept of the photon[15]:

> *Where we depart from a classical intuition for light is a subtle issue ... that there is negligible time delay between the incidence of light and the photoelectron emission. While this is understandable from an atomic point of view - the electron has finite probability of being excited even at very short times - the argument breaks down when we consider the implications for the field. That is, if we persist in thinking about the field classically, energy is not conserved… We just do not have the authority, within the Maxwell formalism, to affect a similar quantum jump for the field energy.*

This is a proper example that depending on the premise, either we discard the (semi)classical model because it contradicts with the energy conservation and the time symmetry from the quantum mechanical point of view, or we could take the dissident stand that the principle of energy conservation reveals unsolved problems in quantum mechanics.

Classical fields with fixed spacetime respect the energy conservation law, but that is not in harmony with the photoelectric effect in short time scales. Because the consensus is that quantum mechanics is "the most precise theory in the history of science" at the moment, we look at the situation through that lens and discard the classical paradigm. To me, this sounds like a rather rough area of problems that are swept under the carpet. This fact alone justifies all the fundamental questions and criticism against the quantum hype. Do we understand the development of the competing theories and how the consensus was reached? Where are the results of the comparison of the models and interpretations? Have we used enough time for the comprehensive experiments? Do we study enough counter-examples?

Reiter's work fuses historical research, theoretical formulation, and experimental practice that we could genuinely test, try to disprove, and observe from many different angles. Not many modern alternative theories come even close to that extent. Since Reiter has delivered the model, the experiment, and the results with his interpretation, I think it is a duty of conventional physics to explain the exact mechanism, how the energy would be conserved in the Unquantum Effect. Might the explanation be some sort of x-ray fluorescence radiation, gamma escape peak, gamma backscattering, double Compton scattering, etc., that gives coincidence rates greater than a chance in the tandem detectors. And even more should be done for severe and constructive criticism, perhaps constructing a variation of the experiment with new parameters that can be tested. There must be some further resolution to Reiter's experiment, which should be issued by a fully elaborated scientific method.

[15] Ashok Muthukrishnan, Marlan O. Scully, and M. Suhail Zubairy: The concept of the photon - revisited (2003).

In his various papers, Reiter points out the exact places where the assumptive theoretical and engineering mistakes happened. The conception of an atom changed rapidly between 1911 - 1932. There were many models and lively development. Reiter argues that decisions related to the atomic model were made hastily. How many physicists there were working with the new ideas, who were responsible, and members in the jury for the decisions?

When I read the historical publications about atomic models in the first part of the 20th century, it did not particularly strike my eye that everything was in the constant stream of testing and verifying things. Experiments seemed to be very rare indeed. Talks, gedanken - thought experiments[16], and theories dominated. It is tempting to think that the comprehensive routine of testing was nonexistent because better automation came only after computers were invented. That would explain why they did not find the variation of the beam-split experiment that Reiter found at the end of the 20th century. The foundational beam-split test should be made with gamma-rays, scintillators, and photomultipliers. Thus, it is the irony of nature that to be able to prove the wave model, the Tandem Piercer Experiment is done in the most particle-like situation with an extremely high frequency gamma-ray spectrum of electromagnetism rather than with a lower frequency x-ray or a visible light like it was done earlier in history.

Photomultiplier alone with too widely distributed pulse-height spectrum has a significant limitation that experimentalists had not realized before. In the Tandem Piercer Experiment, gamma-ray beams produce photoelectric effect in the Thallium-doped Sodium Iodide scintillators in the correct energy arena where the photoelectric effect does not get mixed with the Compton effect. That shall form a proper detector setup. According to Reiter, when detectors are oriented in a tandem geometry, and the gamma-ray pierces both detectors, it would reveal the real substance of light and allow us to see through the illusion. Who would have ever thought of this kind of experiment?

Of course, there is a big risk when resurrecting old theories. If we stick only with the grandmasters of modern particle physics: Lenard, Lorenz, Planck, Einstein, Curie, Heisenberg, Schrödinger, de Broglie, Noether, Bohr, Born, Dirac, Pauli, etc., we may fall off the wagon of addressing issues they just could not handle, but which are well examined in the 21st century. It is not at the reach of this essay to address the most recent development in these topics. But, certainly, knowing the original papers of the founding fathers and knowing the historical development of particle physics is a significant advantage in understanding the current controversy.

One relatively common plea to impugn Reiter's experiment is that it has not been accepted and studied generally by physicists. It is a common pitfall to think that inventions and discoveries would happen overnight. When we read in the science magazines that something new is found, we might get the wrong impression that something happened suddenly or that something is definitely proven. Often it is quite the opposite, especially if individuals do the work without institutional horsepower.

Verifications might take dozens, even hundreds of years, due to required technological advancements and the critical path everything goes through in a validation process in a scientific community. For example, gravitational waves, black holes, slowing clocks in gravitational fields, and many other predictions made by Einstein’s relativity theories have been experimentally tested

[16] https://plato.stanford.edu/entries/thought-experiment/

just recently, almost a century later than they were first speculated. Verification of the relativity experiments is still under debate, in the dissident world, at least.

Unfortunately, some could also abuse the long acceptance time as a defense to any theory. Superstring theory has been under heavy criticism recently because it could not hold to expectations in the last twenty years. Logically speaking, it is *not* possible to show that superstrings can *not* get evidential support in the future. By the criteria of slow progress, string theories could still be going on for many decades and turn out to be useless to anything else but mathematical achievements. Did we suddenly get into other thoughts about the principle of falsifiability?

Some models are dismissed even if evidential facts support them. That is alarming. It raises the question of what causes this social thing to happen? How have certain people earned their position to present quantum mechanical fantasies or subtle modifications to Einsteinian relativity where other people would directly be called heretics or denials? Some social platforms such as Reddit, StackExchange, and YouTube have started to act as police in this subject and ban people who offer critical non-mainstream theories. It is about information warfare, the back kick culmination of the post-truth that I think science will not benefit in the long run. The extensive worldwide list of dissident scientists[17] shows how many flourishing ideas there are beyond mainstream science. We just need to distinguish scientific dissent from totalitarian denialism and be ready to reap the fruit.

Beauty, truth, or both in theories?

There is no such thing as a sudden acceptance of a scientific theory, not to mention swift paradigm changes and revolutions. It has also been said that - at least in theoretical physics - nothing can ever be definitely and finally proven. One can show only the supporting evidence from the measurable event. Sometimes observations come first. Sometimes theories are first. But eventually, they should agree.

It looks like some theories are nurtured to maintain hope without any evidence. These theories rely on the beauty and symmetry factor coming from the mathematics of the theory. The principle of elegance and simplicity has guided many theorists to successful discoveries in physics, but could these principles lead us astray as well? The German theoretical physicist Sabine Hossenfelder argues that it can[18]. The current overall stagnation of physics is due to praising beauty and symmetry argument, according to her.

If we think beauty is a subjective view and can hold researchers' personal semantic meanings, I believe any argumentation pro or against beauty will fail as a generalized principle. Would you trust your nose if it leads to faults, disharmony, separateness, malfunctioning hypothesis, illogicalness, and wrong answers? Anything that tries to achieve truthfulness is a beautiful orientation from the philosophical point of view. Some people might take symmetry-breaking models of reality as well as dreadful statistical data as an astonishing, gorgeous, and harmonizing idea. If we are guided by truthfulness in the form of beauty, does it really make sense to argue whether beauty is misleading

[17] Jean de Climont: The Worldwide List of Alternative Theories and Critics, 2020.

[18] Sabine Hossenfelder: Lost in Mat - How Beauty Leads Physics Astray, 2018.

or not? Those virtues would be strongly tied together. It would make every true theory beautiful. But every beautiful theory is not necessarily true in the sense of having a physical counterpart in the known world. That could be the trap.

Finally, there is this Einsteinian danger zone. Suppose one would deliberately or accidentally challenge any of the mainstream accepted theories of Einstein. That would give a quick green card to the promised land of waste to such scientists. In the Threshold Model, the unquantumness against the quanta of the photoelectric effect could be regarded as an insult to Einstein's heuristic Nobel work[19]. This is considered very, very bad by loyalists.

Summary of Reiter's research in his own words

Reiter explains all these controversial points in his works, so it is not short of comprehensive work and careful thought. One needs to dig deep behind the different layers of the research to see how these questions are addressed. In the more recent reply[20] to Arvin Ash video about the Bohmian Pilot Wave Quantum theory, Reiter gives a nice summary of his research, quoted here entirely with his permission:

> *In the early days, there was the accumulation hypothesis, also called the loading theory. It was worked on by Planck, Sommerfeld, Debye, and discussed by Lenard, Millikan, Kuhn, Whittaker, others. Planck explained in his second theory of 1911 that it was continuous absorption and explosive emission.*
>
> *Tests were performed on the idea most famously by Lawrence and Beams to find the Element of Time in the Photoelectric Effect. Its results were misrepresented in many famous textbooks like Halladay and Resnick to make us think that the accumulation hypothesis was wrong. The hypothesis was not represented fairly because those textbooks (and other) treatments did not consider a pre-loaded state that would explain the discrepancy between measured time and calculated time.*
>
> *The way it worked, according to Planck, is that h was a maximum value and that action can be sub-h, but experiments would not see it. I figured out how to see it in the beam-split coincidence experiment. That is a famous test of quantum mechanics that is really a physical test of Einstein's definition of the photon.*
>
> *According to Einstein, as stated by Bohr in his book, Atomic Physics, and Human Knowledge, a photon would go one way, and only one way, or another at a beam splitter, but if you reconverge the beam, you would build up an interference pattern. This is the real wave-particle duality.*

[19] https://en.wikipedia.org/wiki/Annus_Mirabilis_papers#Photoelectric_effect

[20] Reiter's comment in Arvin Ash video: https://www.youtube.com/watch?v=eNJFUo7yHhQ (6/4/2021).

The first part of the thought experiment, the beam-split experiment, was performed by Clauser and later by Aspect. They did it with visible light and tried to assure us that quantum mechanics was correct. They made major mistakes, mostly due to not understanding what would be a reasonable alternative to QM.

The conceptual breakthrough I discovered was to do what Planck did to h, also upon e and m, of the electron. If you think the electron is a particle with mass m and charge e, the photon is inescapable in the photoelectric effect experiment. A charge can be understood as thresholded because the quantized nature was deciphered in experiments of zillions of charges that rallied an ensemble effect.

There are other details of my theory, of course, but the important part is that I did the experiment that demonstrates the distinction between QM and what I call the Threshold Model. We compare coincidence rates in the beam-split test to the chance rate. QM predicts chance. I am the only one to do the test with gamma-rays. Surprise! Coincidence rates exceed chance rates big-time, like 10 to 100 times, depending on how it is done. It is not a special case, it is repeatable, many sources of artifact were eliminated, and it varies as a function of physical variables in ways that make sense.

Then I did the same thing with alpha-rays. The atom does not always act like a particle either, and we expect that because rest mass also shows wave-particle duality. These tests and my theory reveal the flaw of QM and resolve the wave-particle problem.

Based on the private conversations with Reiter, it is clear that he does not deny all quantum physics. Quantum mechanics mostly work, as we can see. But, it cannot explain the anomaly shown in the Tandem Piercer Experiment. Reiter's main point is to clear out the paradoxical wave-particle duality and clarify that the semiclassical Threshold Model could explain all weird, counterintuitive quantum phenomena. At first sight, this seems plenty said, but on the other hand, many of the concepts in quantum mechanics are inseparably connected. If the beam-split experiment can be explained by other means, it would yield foundational ideological effects cascading through the whole conundrum of quantum theory.

Bold claims

Controversy is the main ingredient of the natural philosophy of science. There is a constant struggle between experiments and explanations of the experiments. Controversy happens before anything is shown; it stays meanwhile and continues afterward when all should be clear and certain.

The Tandem Piercer Experiment indicates an anomaly that may require an update to the quantum mechanical model of particles. Moreover, it may suggest even new physics not explained by the current Standard Model. That is confirmed by the Finnish theoretical physicist Dr. Matti Pitkänen. He has researched quantum mechanics since the 1980s when he started to build his own Topological Geometrodynamics theory that unifies quantum mechanics and Einsteinian relativity in his Ph.D. thesis.

Pitkänen takes the results of Reiter's experiments seriously, although he does not support the original conclusion made by Reiter. Pitkänen has spent a significant amount of time understanding Reiter's experiment. I was often amazed how a purely theoretical approach can eventually achieve the same results as experiments. It just does not happen without going through endless iterations and thought processes.

Based on personal collaboration with Reiter and Pitkänen, I now know it takes a considerable amount of time to investigate other people's work. Anything will take, if we start to think about it ourselves rather than rely on the previous knowledge and general consensus. In some sense, we need to buy the idea and see the world through it to adopt enough information to discriminate against the new theory. That requires close teamwork and collaborative methods from the inside out rather than trying to operate merely as an objective operator. That was one of my most important lessons. The holistic view comes from having both the inside and the outside look at the topic, subjective and objective combined. That asks for social and cognitive skills along with the other scientific virtues from the researcher.

Pitkänen has built up his interpretation[21] of the Unquantum Effect from the Topological Geometrodynamic[22] point of view. He uses a coherent quantum state of N-gammas to explain how there could be a single appearing gamma[23]. It has a similar state in the quantum realm, or maybe even the same as the Bose-Einstein condensate. If we presume that a) quantum mechanics is ok, b) the experiment result is tangible, and c) the condensate could happen at room temperatures, then we might want to expand the theory of quantum mechanics. It would be less painful than totally leaping over the quantum jump.

Can the N-gamma model explain convincingly why the true coincidence test gives us uniform distribution meaning that scintillators show only one detection at the time? And, how could experiments demonstrate that N-gammas spreading in the same direction are real? We have the same criteria here to fulfill; all phenomena related to the experiment must hold up, not only the special cases.

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21 https://www.researchgate.net/publication/352537350_TGD_based_interpretation_for_the_strange_findings_of_Eric_Reiter

22 Matti Pitkänen: Topological Geometrodynamics, 2016

23 Based on private conversations with Matti Pitkänen and his draft paper "TGD based interpretation for the strange findings of Eric Reiter" in 04-06/2021.

In the near future execution of the Tandem Piercer Experiment, our team will be testing these models as well as bettering the test by keeping x-ray fluorescence and gamma escape peak predictions of conventional physics particularly in mind. We expect to find it not a problem because the pulse-height filter already addresses the fluorescence or other not-gamma-related effects. Unfortunately, there is no such thing as absolute certainty in this business.

Claims about the new physics, new particles, new interactions, anomalies, and so forth are easy to say for brave people, but at the same time, they are insanely bold. Only particle accelerators can indeed do most of those kinds of experiments nowadays. As famously said by Carl Sagan: "*Extraordinary claims require extraordinary evidence.*"

But, there might still be exceptions like the American radio amateur Grote Reber who started his radio astronomical survey in 1936 and worked for a decade alone before he got recognized. Astronomy and biology are starting their new age of discovery when citizen scientists are getting along[24]. Particle accelerators can already be built at a home garage[25], as did Michio Kaku at his high school age. Many modern smartphones would outperform The Deep Blue supercomputer that became famous by beating Garry Kasparov in 1997.

It is easy to prejudice work that is in progress or offers controversial considerations. We may take a quick, clean, and lazy path, trusting that the house will eventually win, or we can take a dirty, unpredictable way, make our bet and live in excitement. For a few celebrities like Stephen Hawking, betting was adequate, but without the fame, it would be regarded as a shame for most of us. That should not be the case.

With less secrecy and more encouragement, nowadays, we have better possibilities than ever for creating new experiments and theories. That would require a shift in the scientific methodology where the study process would be made transparent to the public. The results need to be shared without paywalls and overly complicated scientific jargon so that the public can participate in projects.

24 https://en.wikipedia.org/wiki/List_of_citizen_science_projects

25 Build your own particle accelerator: https://core.ac.uk/download/pdf/327368343.pdf

Science - the duty of a citizen

> *Science is a universal human right, according to UDHR [Universal Declaration of Human Rights] Article 27. Therefore, everyone should have the right to participate in science, be heard, and present their research in relevant scientific media*[26].

The setup for the Tandem Piercer Experiment is not that hard to arrange. It requires a few weeks of dedicated spare time work. My subject of astonishment is that nobody has tried to replicate the experiment earlier, although Reiter has been demonstrating it for twenty years already. After a few months of looking at the old discussions and building up new discussions on the topic, I cannot think of any other good reasons but prejudice over the proposal.

Exaggerated expressions about the illusory nature of quantum mechanics and the omission of particles on behalf of waves might have shot to the presenter's leg. How could you attack quantum mechanics by the experiment that uses quantum mechanics? Doped scintillators, gamma-ray source isotopes from the nuclear fission products, electronics in the photomultipliers and oscilloscopes, they are all based on quantum physics, right?

Technically speaking, since Reiter explains the Unquantum Effect by the non-quantum Threshold Model, he is not arguing quantum mechanics against quantum mechanics, as the other side would claim. Outrageous straw man argument does not work because it puts words on a mouth. Explaining how all other things work in the world, that is not a thing for a single man to do. Apparently, a lot would be rewritten and many things that were drawn under quantum mechanics would be rearranged, if the anomaly gets verified and the Threshold Model is true.

Moreover, why wouldn't you be allowed to express your honest conclusions as you see them in your own experiment? The area of conjectures is a free zone, after all. Anyone can and should build their interpretations based on the experimental data independently. If it is done without knowing each other, even better.

Other prejudices might go to the outline of the articles of Reiter. His research has been pretty organic. It may or may not comply with the rules of some institutions and peer reviews. Critics have been about the incoherent layout of the publications. The defense is that there is only that much one man can do. While I embrace individualism in thinking, I must also recognize the power of teamwork in scientific contribution.

I'm thinking of science as a road to reality, not as a throne of truth. Peer reviews should be places where scientists are assisted in orienting the research outline rather than filtering what is acceptable and conforms to the mainstream - general opinion of scientists - and what is not. If peer reviews are places trying to build up authority, the whole idea of the scientific method fails at that point.

My impression is that there is increased criticism of how institutionalized science in its hierarchy and methods fails. The reason for their unwillingness to investigate unconventional

[26] See Marco Perduca's comment in Nature: https://www.nature.com/articles/d43978-021-00013-w

proposals may relate to the issue of economy and capitalism that rule over the hunt for the truth. Proposals will not get through the walls of Jericho but via certain authorized gates only. It is not enough to be correct, but you need to provide compelling content for a more complex and demanding society of researchers.

Peer-reviewed journals are used kind of a joke after all because anyone can discredit journals in the discussion favoring their own preferred journals and supposedly showing their ability to critical thinking. One cannot build any constructive dialog when soft-engineered by questioning what a respectful journal is and what is not. In the end, only the articles published in Nature and Science magazines will get attention and significant publicity which might be beneficial to the individual researcher.

The peer-review tradition that started from the London Royal Society in 1665 had its place, but for example, Einstein's 1905 papers did not go through any referees. Instead, they got published solely by editor's choice, might it have been Max Planck or some other person in *Annalen der Physik* German journal[27].

That said, Reiter's work has been published in the peer-reviewed journal "Advanced Studies in Theoretical and Experimental Physics: Progress in Physics, vol. 2 / 2014". It could have been more profiled, said Reiter. It looks like it has been a terrific job to get a voice out into the community.

Most physicists just refuse to comment on anything related to intensely controversial topics in public. That is a sign of silent pressure to dismiss some selected work and favor the other that fits the currently accepted range of theories in science. Indeed, I do not believe that this is how the research should be done, especially a genuine scholarly study. On the contrary, it reveals to me an unsophistication in pursuit of truth.

Personally, as used to free and independent thinking, lifetime learning, and divergent communication in other areas in my life, I am a bit worried about this fact. I see a close relation to religious-like scientism in the structure and foundations of some regions of science.

It is no coincidence that some scholars have started to talk about the church of science, where a community tightly holds up the strings of currently accepted views. Yet, I do not think that there is any single institution behind scientism. No conspiracies. It is more like a tendency toward a certain kind of human thinking that collects similarly idealized people to defend antiheretism. We should have better tools and more nuanced thinking for dealing with the demarcation problem.

It is sometimes claimed that from the 19th hundred onward, citizens and laypeople could not contribute anything to science anymore, at least hard sciences like physics. Only decades of academic study agreeing methodological positivism, with huge loans paving the way to the elite group of scientists, or the multibillion-dollar lab teamwork, worldwide satellite telescope installations, and nuclear collision projects are counted as real science, a sign of academic inquiry. The more money it takes, the more real it is. Have we become $ize-blinded?

In his latest writing, "Something is Rotten in the State of Quantum Electro Dynamics", the independent scholar Oliver Consa argues that politics and world economy came into the science

[27] https://mindmatters.ai/2020/05/einsteins-only-rejected-paper/

picture at the time of the Manhattan Project. An enormous amount of money and power was concentrated on the hardcore physics by the atomic bomb explorations and people who worked with them. Ivory towers and hegemony were built, and it is still kept up with certain academic-political requirements. In the 1960s and forward, particle physics and cosmology got married by colliding interests, and today they hold the most strictly ruled foundations of science, where there is no room for the different schools of thought. Postmodern relativistic truth does not fit their agenda.

However, this is good news for citizen scientists who want to study the world's phenomena or contribute to the common good purely from their innate interest. The Tandem Piercer Experiment can be done with the home lab equipment. This experiment is a fantastic opportunity to study fundamental physics in theory and practice. It is an excursion to the social aspect of science too.

We have made our best in the Tandem Piercer Experiment to do it all responsibly as citizen scientists should do[28]; carefully and honestly investigated, critically, truthfully, open-minded, the team reviewed, transparent, replicable, well tested, intelligibly documented, and communicated in the old fashion of the mentality of a natural philosopher with a modern twist of understanding and technology.

Of course, one should not underestimate the time needed to properly understand the Tandem Piercer Experiment's details. Even seasoned physicists might not get everything right by a short peak to the Tandem Piercer Experiment and the Threshold Model. I have witnessed this several times already. Probably only a few people have ever heard or taken a closer look at the second theory of Planck before. The inner functions of the scintillator detectors and the coincidence counting are hardly known but to specialists beforehand. They are not hard to understand, simply not a piece of common knowledge shared in elementary schools.

[28] Ten principles of citizen science: https://osf.io/ugy4t/

Wave-particle duality and photon

Another good thing for a layman or people coming from different fields might be that they have no established theory load and bias that one might get from the physics orthodoxy. But even then, the intrinsic idea of atoms, particles, energy, and photons might be a challenge. These ideas come from a society filled with the conventional models of things we have achieved in science in the last few hundred years.[29] Blobs of objects are easier to grasp, unlike waves and fields, especially mathematics related to them. Particles tend to come so naturally from the mouth.

I have encountered the same problem on the other topic of my interest, namely the concept of time. If our position is that time is not fundamental, or it is an illusion, we are kind of dragged into a paradoxical situation. Our everyday talk is surprisingly full of nouns related to timekeeping. It is almost impossible to talk without referring to time. Surely time must exist!

Interestingly enough, it turns out that only in the last decade, we got closer to having objective experimental evidence for the single-photon corpuscles. The best substantiation of the photon is based on the technique called spontaneous parametric down-conversion, where the signal and idler photons are statistically post-calculated[30]. Weirdly, in statistical analysis, because it is an approximation, we must detect less than a single photon too, or the average would be greater than one photon. That is against the idea of quanta, which should mean the smallest packet of energy. Difficulty in defining the photon is still actual as it was in the 20th century[31]. Definitions vary from a point-like geometrical abstraction or a stochastic vacuum fluctuation in the quantum field to an event in a photomultiplier, a wave packet on the Maxwell waves, or simply to a statement that we should not ask what photon is but instead define that a photon is what happens[32].

Initially, we built the wave-particle duality theory based on thought experiments and effects from electron diffraction. Then we tested the theory in Bell's inequality experiments by assuming a particle-like model solely and not assuming a wave-like model[33] as a control model. The concept of a photon in quantum experiments was a convention only, albeit a strong one. It was later shown that the earliest experiments, starting from G. I. Taylor in 1909, could not produce single photons assuringly because the photon bouncing effect was not realized[34]. Also, the photoelectric effect itself cannot be used to argue unequivocally for the particle nature of light[35]. We need much more direct and convincing evidence to answer the questions: what is a photon, what is the size of the photon, and how is the single-photon made and observed[36]?

Tandem Piercer Experiment is a gamma photon coincidence counting experiment by its core, which is why these matters concern me greatly and were quite surprising findings to me. Not too

[29] https://www.scientificamerican.com/article/the-human-eye-could-help-test-quantum-mechanics/

[30] https://www.nature.com/articles/s41598-017-16773-9

[31] Arthur L. Robinson: Demonstrating Single Photon Interference - Even a single photon can manifest both wave and particle natures according to quantum theory, but demonstrating this is not so straightforward (1986).

[32] Ashok Muthukrishnan, Marlan O. Scully, and M. Suhail Zubairy: The concept of the photon - revisited (2003).

[33] https://www.nature.com/articles/s41534-018-0117-8#Sec8

[34] https://aapt.scitation.org/doi/full/10.1119/1.4955173

[35] Philippe Grangier: Experiments with single photons, 2005.

[36] Chandra Roychoudhuri, Katherine Creath: The Nature of Light - What is a Photon?, 2005

many demonstrations of the wave-particle duality talk about the engineering side of the experiment, how single photons (or electrons) are made, or how they behave throughout the test. Instead, we have concentrated on demonstrating the paradox only with simple naive geometrical drawings and animations. Undoubtedly, the double-slit experiment with light is amusing when it is presented as it usually is. Still, I think we should be even more interested in the experimental setup, how it is built and manufactured, not just repeating the result, which was a thought experiment originally without direct evidence for several decades. I fear that the more recent experiments are biased by the conventional quantum mechanical models and do not give equal footing for alternative theories and considerations.

Building new intuition over illusion

It should be easy to intuit from an everyday experience of a human how cups of water can be prefilled with water. When the cups get enough water, they will spill over. We also see an excellent analogy of the threshold in a situation where a high-note vibrant singer can break up the glass with the resonating power of the voice. It is a sudden event as if it was done by shooting a bullet into the glass.

Thus, would be the pre-loading Threshold Model in action. Electron clouds start to resonate by the absorption of the gamma-rays. For the currently known instrumental methods, the value of the pre-loaded state is unknown and unmeasurable; we would say a hidden variable. When the threshold barrier breaks, an atom emits a fixed amount of energy called quanta. From that on, Reiter hypothesizes that emission happens in a wave format only. The same would happen with matter waves (alpha particles), not just with electromagnetic waves, as in the case of the gamma-ray experiment. But, this is not to be taken like there is no need for the particle concept. A particle is something that holds itself together, also known as a soliton, which is a packet of waves that maintains its shape.

It is different from the all-mystical quantum jump, where something changes a state from one to another without any intermediate steps and time. Or, let it be a quantum-entangled pair of particles related to each other in some strange way, possibly from the different sides of the universe, breaking the speed of causality laws. These were challenging ideas even for Einstein to accept. Should we just get over it without any journalism?

Intuition can be developed, matured, changed, programmed again by studying and repeating. Whether something is intuitive or not is not a good meter here. It is just something we are forced to start with. One can get used to the weirdness of quantum mechanics. Suddenly, the wackness in turn may begin to feel intuitive.

By the beam-split, the dual-slit, Bell's inequality theorem followed by the related experiments, and exciting twists in thinking, we are deceived into thinking that quantum nature is real, even if it is crazy. Classical laws cannot explain certain fundamental phenomena of physics from the Planck scale to multimolecular scales. Only above those scales, the classical equations start to dominate with the relativistic limits on the macroscopic scales. Deep in the level of the quantum foam, all is about probability waves and either the collapse or branching of the waves. That is a common conception.

It is quite striking to think if we have missed something crucial in this narrative, yet can we do so much with quantum mechanics.

However, we should not forget that quantum mechanics is just a mathematical formalism that does not even try to tell anything about the world itself. It is up to our philosophy or worldview, whether we accept the realistic or the psi-epistemic interpretation of quantum mechanics[37], or some agnostic variation of them. But it does not remove the fact that probability waves are nothing close to things we will ever sense in human interaction with the world. Interpretation of quantum mechanics has always been an enormous challenge. People take different positions on it. Are we allowed to speculate, or just calculate the Copenhagen way?

If we think this a couple of times more, we might conclude that quantum mechanics is even worse than an illusion because it is not meant to illustrate the world as it is. It only shows how to calculate the smallest possible invisible things in the world with insane precision for ensembles. Magnetic momentum has been predicted to a whopping 12 decimal accuracy compared to the actual measurements, although Alexander Unzicker and Oliver Consa claim it was not factored honestly in the beginning. Yet, we do not get the size of the proton but only to the second decimal with the same quantum field theory (QFT), namely quantum electrodynamics (QED), so we need to get help from quantum chromodynamics (QCD). At the moment, many experimental and ad hoc parameters are added to the quantum theories making it a big mess where only specialists are able to shuttle. These technical issues are a separate issue themselves which certainly are not helped with the fact quantum mechanics lacks explanatory power. It drives us to either give up and follow the math or open our mind for mysticism. Well, unless we are open for philosophical discourse and require that science should also explain the world, not just act as an equation solver and calculator.

The metaphysician has yet one more card up his sleeves against four ace physicists. Are the classical concepts of waves and particles any closer to reality than quantum descriptions of the world? What does it even mean that some mathematical equations or understanding based on some models of the world would be closer or further from reality? Do the more precise measurement and prediction imply better understanding, or are we just on the way to defining understanding by that requirement? Maybe we have forgotten the mesocosmic observer's role in the equation while looking at and giving the special role only to the tiniest and the most gigantic things in the world. In his critical writing "Critique of Physics Theory Inconsistencies", Alex Vary writes:

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[37] In the jungle of concepts in the philosophical interpretations of quantum mechanics, anti-realism means the epistemic position (psi-epistemic) that we can have correct information or knowledge about the rules and laws of nature utilizing quantum mechanics. Still, anti-realism does not make claims about what reality is. The ontological position (psi-ontic) is that the quantum wave function (denoted by Greek letter Psi ψ) is reality. Thus, the psi-ontic position is also called quantum realism. Depending on the interpretation, the wave function can be separate from the physical reality. The collapsed wave function may exist in the physical world since it resolves to real number values instead of superimposed complex trigonometric density functions. So, both from the psi-epistemic and the psi-ontic perspective, superpositions of the waves could be real, but not in our dimensions and not for our comprehension. Finally, participatory realism or QBism takes the observer of the experiment to the central role. In this interpretation, a quantum state represents the degrees of belief in Bayesian statistical form, not reality. QBism differs from Copenhagen's interpretation, where the results of the experiment or observations are objective and real for everyone. QBism does not take a strict position with ontology.

> *We argue that the mesostratum is the transcendent foundation or substratum of our material world, the cosmos, and that cosmic physiostratum space-time is a granular discontinuum - that the physiostratum consists of oceanic array of tessellated space-time parcels.*

According to Vary, the conscious mind of the observer resides in both realms, and mesostratum would "*complete our understanding of fundamental physical reality.*" The study of consciousness has already started to retrieve scientific accuracy, rigor formulation, and instrumental experiments far ahead of pure philosophical discussion in the earlier decades. I expect this field to flourish in the coming decades when the old too simplistic mind-matter debates based on previous eras' logical empiricism ideology gives way.

Something new and intelligible

Reiter tries to make things sensible again. Rephrasing that something is both particle and wave simultaneously, carrying the idea of the wave-particle duality even if it seems contradictory and paradoxical, raises concerns about the consistency of our thinking. If the potential energy held by what we call a photon is indeed a semiclassical wave and resonating frequency only, and if we can show it by the experiment, then there are no paradoxes on that part anymore. The probability wave feature fades away, and the associated particle behavior with all strangeness related to them. It should be a good thing since paradoxes are almost the same beasts as infinities are in physics.

Solving the wave-particle duality's consistency problem by erasing quantum mechanics comes with a considerable cost, however. How would the new theory explain the rest of the phenomena that have been planted under the quantum umbrella? Who would be doing all that explanatory work? There is only so much time in one person's lifetime. It is not sensible or fair that one person should read all the quantum-related experiments and the following articles that have been published in the past hundred years, participate in those discussions, and give comments on all of them. A reasonable amount of precisely selected material in quantum mechanics should be enough to cover the demand for showing the familiarity of the scene.

Reiter's view is that most quantum phenomena we think of as separate revert to the beam-split, the dual-slit, and the coincidence counting experiments. We have built a complicated system of concepts that hides relatively simple foundations. Reiter's debate's single most crucial thing is that one should really try to explain the Tandem Piercer Experiment by conventional physics. There has been a need for experimental data to overcome the stagnation of physics over the last few decades. Novel experiments are rare and precious substances in our times. The experiment should have the privilege of being in the number one position because it is something concrete anyone can work with. The rest is speculation.

If any new theory is both giving the same or better predictions and simultaneously is simpler yet capable of explaining the world intelligible, could we think of it as a better candidate than the old ones?

It is hard to see behind the illusion of quantum mechanics, Eric Reiter has said. Some theoretical physicists like Steven Weinberg, Sabine Hossenfelder, Lee Smolin, and Roger Penrose argue that quantum mechanics cannot be the final answer. So thought Einstein. Quantum mechanics has brought highly suspicious theories and overly complicated experiments like the Delayed Choice Quantum Eraser[38] recently challenged by Hossenfelder.

Criticism is not just because quantum mechanics is formalism only and cannot explain the world coherently. The main reasons for the doubt are the measurement problem, the dimension problem, and the undecided role of the observer. Reason number four is that quantum mechanics cannot hold up with general relativity. But that is a whole different story relatively unrelated to the topic in question.

Whether quantum mechanics, the quantum jump, or the world itself is an illusion, that is with further ado waiting for the repeated experiments, further study, and bold thinking.

Acknowledgment

I have been advised in the experiment by Reiter in highly educational video chats we have had since April 2021. I have had numerous conversations on the topic with Finnish theoretical physicist Dr. Matti Pitkänen and an anonymous physics teacher in Finland, to whom I am grateful to get important critical views. In 2020, Pitkänen initially introduced the papers of Reiter to me. In spring 2021, I attended one of Reiter's online webinars, and eventually, we got into closer collaboration.

In summer 2021, I was delighted to have an opportunity to present[39] the experiment and inform the progress of it in the Discord “The Portal Book Club” in the Beta Study Group of Roger Penrose’s monumental work “Road to Reality” led by Ukrainian software engineer Iaroslav Karkunov. Also, the lengthy email discussion with Physics Foundations Society[40] has been helpful. I feel privileged to be able to participate in all these.

38 https://www.youtube.com/watch?v=RQv5CVELG3U

39 PowerPoint presentation of the Tandem Piercer Experiment: https://drive.google.com/file/d/1WUNwkBI4rkwGWLTAtJiZooO06VlrT72s

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5) World Science Festival:
https://youtube.com/c/WorldScienceFestival

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23) Matthew O'Dowd:
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24) Eric Weinstein:
https://www.youtube.com/c/EricWeinsteinPhD

25) Stephen Wolfram:
https://www.youtube.com/channel/UCJekgf6k62CQHdENWf2NgAQ

Appendix 1

Quantum mechanics, in the view of this essay

In 1800, the wave model of the light had just fixed its status in optics, and the wave model became foundational in Maxwell's electromagnetic fields. In 1900, Max Planck postulated that electromagnetic energy could be emitted only in quantized form, in packets of a fixed size. This started the shake of the pure wave model. Planck and his collaborators continued developing these ideas during the following years, which eventually became quantum mechanics (QM). In 1918, Planck received the Nobel Prize in Physics for his work on quantum theory.

In 1905, Einstein used Planck's mathematical treatment of the ultraviolet catastrophe in the black body radiation to explain the photoelectric effect. Only, when the electromagnetic radiation has a large enough frequency, that is, each of its photons carries enough energy, the radiation can strike electrons free from metal. Controversial at first, but in 1921, when Einstein received the Nobel Prize in Physics, the law of the photoelectric effect was mentioned as a reason.

The photoelectric and Compton effect suggests that sometimes light acts like particles: it carries energy in fixed quantities. The light particles are called photons. However, occasionally light acts as a wave: when monochromatic coherent light passes through a double slit with a certain size and dimensions, the resulting light waves create the interference pattern. Moreover, this is demonstrated in experiments with single-emit photons, which are thought to highlight the real quantum effect and confirm the dual nature of light. The conclusion is made that light - actually any fundamental matter particle as per de Broglie - has both features. This is referred to as the wave-particle duality.

Theory of relativity

In 1905, Einstein presented the special theory of relativity (SR), which stems from two postulates:

1. The laws of physics are invariant in all inertial frames of reference

2. The speed of light is constant in a vacuum

As a result, adjustments to Newton's laws are to be redone. For example, when observers move at large speeds, Newton's second law as a net force equals mass times acceleration has to be completed with general relativity. At low speeds, Newtonian mechanics still works well as an approximation.

During 1907 - 1915, Einstein developed the general theory of relativity (GR), an extension of SR. The general theory of relativity tells that gravitation is because of distortion of the geometrical spacetime due to masses. Equivalently we can say that mass is due to curvature of spacetime. In 1919, the first empirical evidence to support GR was obtained. In the experiment during a solar eclipse, it was observed that the Sun bent the light coming from distant stars.

The theory of relativity is separate from quantum mechanics. However, there is a strong pursuit to unite quantum physics and the theory of relativity. After creating the general theory of relativity, Einstein tried for almost 30 years to combine QM and GR until his deathbed. It turned out that the task was too tricky. The quest to merge these two theories with the known fundamental forces in the Standard Model is still open. The unified theory is hypothetically called the Theory of Everything, one of the biggest challenges of modern physics among the mystery of time, and the multidisciplinary subject of consciousness in science in general.

Appendix 2

Beam-split and tandem experiment

The wave-particle duality can be studied with the beam-split coincidence experiment. A light beam is split into parts which are then combined. Will the assumed photons be split? Will there be an interference pattern created as the superposition of two assumed merging waves? According to Einstein, each photon goes only one way in the beam splitter, but there will be an interference pattern.

The wave-particle duality is also studied in the Tandem Piercer Experiment developed by Eric Reiter. In the setup, gamma-rays go through two scintillation detectors, which are placed in tandem.

Scintillators are well-researched technical devices that can detect gamma-rays. The Thallium-doped Sodium Iodide scintillator emits optical blue light from the detected gamma-ray, which can then be converted to an electrical signal with a photomultiplier and finally acquired by an oscilloscope for statistical analysis. Isotopes like Cadmium-109 and Cobalt-57 are used to produce a constant beam of single-emit gamma-rays in the right energy arena (88KeV and 122KeV respectively) to distinguish the photoelectric effect from the Compton effect. Background noise, as well as x-rays and fluorescence effects, are filtered with the nuclear instrumentation modules.

It has been found in the Tandem Piercer Experiment that both detectors fire in coincidence at a rate notably greater than chance. When the firing, i.e. full-height pulses/clicks in the detectors, happens in the specific time window usually measured in nanoseconds, it is regarded as coincidental. That indicates a causal relationship between the detectors, a mechanism between the click one and two, which the conventional quantum mechanical model does not expect. By quantum mechanics, there should be just random noise.

As an explanation, Reiter offers the Threshold Model and suggests that light is a wave in the most fundamental level of reality. Only at the emission stage, when electrons have achieved a threshold level from the continuously absorbed and resonating electromagnetic waves, electrons emit energy measured in quanta. Reiter identifies what seems like quantized light as a threshold effect of charge, not a property of light. Reiter also did experiments with alpha particles and got the same result, making the subject even more subtle and interesting.

In conclusion, the Threshold Model by Reiter could explain the phenomena of two full consequent full-height pulses in the detectors, which conventional quantum mechanics cannot explain. That suggests that light is primarily a wave, in contrast to the commonly accepted wave-particle duality.