

Modified QED (MQED) Predicts How to Demonstrate FTL Communication

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ABSTRACT

Canonical Copenhagen QED (KQED) predicts that substantive information cannot be communicated faster than light (FTL) or backwards in time. KQED is essentially just the combination of three assumptions used together to make predictions: (1) the assumption that the wave function $\psi(t)$ evolves according to the time-symmetric system $\partial_t\psi=iH\psi$ where H is the normal product form of the Maxwell-Dirac Hamiltonian; (2) the classical Copenhagen measurement formalism, including metaphysical observers and collapse of the wave function; (3) Fermi's Golden Rule for spontaneous emission. MQED, published in 2015, replaces the measurement part with a new measurement formalism without observers based on what (1) actually predicts. MQED is not a local realistic theory, but (unlike KQED) it might be derived as a good statistical approximation to one. The 2015 paper proposed a decisive experiment to test which is right, KQED or MQED. This paper proposes a simpler if messier decisive experiment, to demonstrate FTL communication, more details of MQED and the possibility in principle of an underlying local realistic theory of physics.

1. Review of Prior Work

Because these are complex controversial issues, the review of prior work and of underlying theory will be relatively complicated, but the description of the new experiment will be much more straightforward. I hope readers can read just the section or sections they are most interested in.

1a. Variations of QED

KQED and MQED are just two of the many, many fundamental mathematical theories which have been developed as starting points to explain how the universe works (even before gravity is accounted for) and to support the needs of the electronic and photonic industries [1]. Figure 1 depicts just a few of the more important ones in a simplified way:

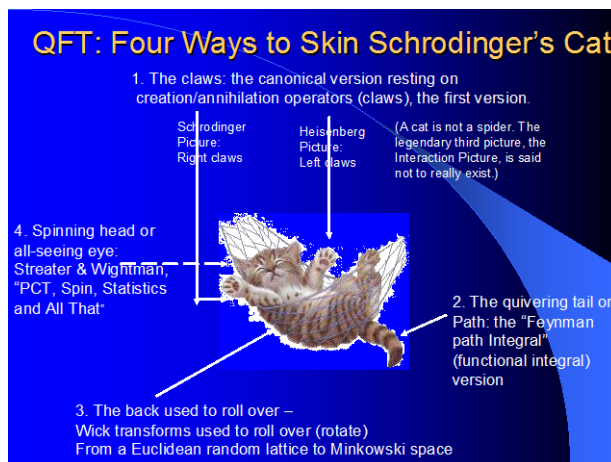


Figure 1. A Few Types of Quantum Field Theory ©PJW 2008

Nevertheless, KQED was the original breakthrough in quantum field theory which won the Nobel Prize for Schwinger, Feynman and Tomonoga, after it successfully explained data such as the Lamb shift and the anomalous magnetic moment of the electron [2,3,4,5]. With a few tweaks building on the work of Schwinger, it is still the primary workhorse of real-world physics modeling of electronic systems [6]. It is also the starting point for the latest work on the foundations of physics by Gerard 'tHooft, one of the three main creators of Electroweak Theory, the most highly tested part of the Standard Model of physics [7,8].

For the sake of simplicity and focus, this paper will not discuss other variations of QED in detail. However, the decisive experiment proposed here and the experiment proposed in the 2015 paper [9] are equally relevant to those variations. For example, the Feynmann path formulation basically replaces the “Schrodinger equation” (component (1) of KQED) with a different pair of equations to calculate the probability amplitude of a possible scenario or path $\{\pi(x_\mu), \varphi(x_\mu)\}$ across all x_μ , shown in the scalar case as equation 3.39 of [10]:

$$Z_{L_0}[J] = \int [D\pi][D\varphi] \exp\left\{\frac{i}{\hbar} S[\varphi, \pi, J]\right\} \quad (1)$$

$$S[\varphi, \pi, J] = \int d^4x \left(\pi \dot{\varphi} - \frac{1}{2} \pi^2 - \frac{1}{2} (\nabla \varphi)^2 - \frac{1}{2} m^2 \varphi^2 - J\varphi \right) \quad (2)$$

But then, in making actual predictions, there is still a choice between using the Copenhagen measurement formalism, as is usually done today, or using the same new measurement formalism as in MQED. This gives us two different versions of Feynman path QED (FQED), yielding different predictions for the experiment proposed here and the all-angles triphoton experiment proposed in [9]! Likewise, the Wick rotation versions proposed by Glimm, Jaffe, Nelson, Schwinger and others [11] also replace component [1] by something else, and require a choice of measurement formalism at the end of the day. Physics will not really know whether FTL or backwards time communication are possible in principle, under any of these theories, until the key decisive experiments are performed.

For the sake of simplicity and focus, this paper will not discuss component (3) of KQED in any detail, as was done in [9] and [12]. Because KQED uses the normal product Hamiltonian, which does not include a zero point fluctuation term, it does not predict spontaneous emission correctly, except with the attachment of Fermi’s Golden Rule, which is just as ad hoc as the usual collapse of the wave function. Cavity QED (CQED) [13,14] solves this problem in a more elegant way, assuming zero point fluctuations, but there are fundamental questions about CQED which have yet to be resolved [15], and it is known that the Casimir effect between two parallel plates does not differ measurably from what classical vanderwaals forces predict (shown by Landau and Lifschitz long ago). MQED explains spontaneous emission without either zero point terms or a Fermi rule, as an effect of boundary conditions, under time-symmetric statistics.

1b. Prior Work on Objective Reality Involving Time-Symmetric Physics

The general fuzzy, abstract idea of backwards time communication is older than the ancient work of H.G. Wells. However, only in 1973 was it noted for the first time that a new formulation of

statistical “causality” at the macroscopic level, reflecting time symmetry, would be necessary in order to allow the possibility in principle of a local realistic theory of underlying physics [16]. Even this year, papers have been published inspired by the simplified treatment given in [17] which assert that “local realistic theories” have been totally ruled out by Bell’s Theorem types of experiment, but in fact they have not. I spelled out the “third loophole” in very direct terms in the same book [18] which contained the original paper by Greenberger, Horne and Zeilinger (GHZ) on triply entangled photons, for Kafatos’ conference back in 1988. It would be possible to rule out local realistic theories by experiments which test that third loophole (the experiment proposed here or the other in [9]), if those experiments favor the Copenhagen measurement formalism, but based on the discussions in [9] and [12] I personally would expect a more interesting outcome. Again, see [9] and [12] for a more complete review.

In essence, we have a clear logical choice between assuming that objective reality does not exist and that metaphysical observers do, or else assuming a new predictive theory which permits FTL communication. As scientists, we should let nature decide, by experiment, even if we disagree about what to expect.

MQED itself is not a local realistic theory, even though it was initially motivated by the search for a local realistic theory [9]. As ‘tHooft has noted [7], there are very powerful practical reasons why QED approximates its basic charged particles, from electrons to protons, as perfect Lorentzian point particles of zero bare radius. After carefully studying [12] and the papers and experiments it cites, especially those in Zeilinger’s group, I conclude that this approximation is probably not consistent with a local realistic formulation of QED which fits those experiments as well as KQED and MQED do. However, if we disprove the Copenhagen formalism by experiment, validating MQED, we also make it possible in principle to develop an underlying local realistic model which does not make that approximation. I do not have a specific deeper model to propose at this time, but have explored some of the key difficulties [19], and now see a promising way forward – beyond the scope of this paper.

1c. Prior Work on Time Symmetric S&T As I Define It

Aharonov has often proposed a general concept of “time-symmetric physics” which, he emphasizes, is just a matter of interpretation, giving the same predictions as Copenhagen quantum mechanics. Clearly my version is a different thing, even though many of Aharonov’s words sound more and more compatible in spirit with my version. Indeed, in Savitt’s seminal anthology on the arrow of time [20], the formulation in Aharonov’s chapter would lead to the same predictions as Copenhagen. The only paper which clearly fits my version of time-symmetric physics in that anthology is the beautiful paper by Huw Price.

How can we avoid semantic confusion when there are so many versions of time-symmetric physics discussed, especially by philosophers relying heavily on verbal constructs? Since 2008, I have defined time-symmetric physics exactly as specified in [12] – as a combination of some type of mathematically well-specified dynamics together with a measurement formalism which obeys the specific rules laid down in [12]. The term MQED is more specific, since it was defined in 2015 [9], with the same definition as in the abstract of this paper.

Both KQED and MQED offer predictions only when specific models of specific macroscopic measurement types are available. The “collapse of the wave function” model of the polarizer, used in KQED, is well-known. In [9], I reviewed new and different polarizer models, all compliant with the rules in [9], which I previously used to develop local realistic lumped models of the Bell Theorem experiments. These specific models lead to different predictions from those of KQED for the experiment proposed in [9], which has not yet been performed.

I plead with my colleagues in computer science and elsewhere not to publish a new paper next week, trying to redefine MQED as “Melania’s Quantum Evening Dress,” confusing the issue of what kind of experiments need to be performed.

More seriously, the decisive experiment proposed in [9] is a variation of the classic GHZ experiment, varied by measuring triple coincidence rates for all angles of the three polarizers, not just the “horizontal” and “vertical” alignments studied in the past. This is a crucial first step towards building simulation design packages for the types of new technologies discussed in that paper, accurate enough to allow us to exploit the new effects. It is an easy variation for any laboratory set up to do the full GHZ experiment, but Zeilinger’s is now the only lab outside of China which still has that capability, so far as I know.

Actually, an attempt was made to do the all-angles triphoton experiment, under NSF funding, by the same experimenter who performed the first high-precision Bell’s Theorem experiments using photons entangled by Down Conversion (SPDC). However, at the time, the GHZ/SPDC apparatus was no longer available, and the results using a thermal light source disagreed both with KQED and with MQED, if it is assumed that the thermal light source was a valid source of the GHZ asymmetric state (as KQED predicted it should be)! [21] This curious result led me to ask how to model other components of the system, within the alleged source of a GHZ state, and that led me to the realization that the ordinary Maxwell-Dirac equation is unavoidable at that level for now, to describe what happens in the passive macroscopic components – except for black body sources.

1d. Extension of MQED Leading to New Experiment and Possible Further Technologies

The key driver for the new experiment to be proposed here was a discussion of future possible technologies, for a workshop in which key NATO futurists pushed me to think about what might be possible, thinking out of the box [22]. Above all, I was asked: under MQED, is backwards time communication (for early warning) possible in theory, and what is the path to finding out whether and how to do it?

I hereby add one more object, in addition to the detector, the polarizer and the source of entangled photons, to the MQED “library” of macroscopic object models. I add the Black Body, as a time-symmetric macroscopic object, a “passive” object [9], and not a source of time-forwards free energy. The model in MQED is simply that such a body, in equilibrium, emits photons equally both in forward and backwards time, based on its usual emission spectrum **which, for an ideal black**

body, is the same as its absorption spectrum. Of course, the previous work on Bell’s Theorem experiments begins by noting that no physical polarizer is ideal, and the same is true for black bodies; however, I would expect that Raman spectroscopy of heated incandescent light bulbs would probably show an absorption spectrum similar enough to the emission spectrum to allow the proposed FTL demonstration to work. Conversely, if Raman spectroscopy validates this experiment for a specific type of incandescent light bulb, and if no FTL effects are seen, this would rule out time-symmetric statistics as I define it, and rule out local realistic theories of physics as well.

2. Proposal For an FTL Demonstration

I first saw the vision of this new experiment in January 2017 [23], and have worked out several practical details in email discussions since. I am posting this new paper today in part because a few of the ideas have started to pop up other emails without attribution, and it is important to keep different pieces together, in order to get the full benefit to scientific understanding and to technology.

The new experiment should be much easier to perform than the experiment proposed in [9], because it only requires a source of two entangled photons. This would allow it to be done in any laboratory with a traditional SPDC source, like the one sold by the company qtools, with supplementary components available to a wider community. It should also allow quick replication and replication in parallel locations, as is essential when proving such an important frontier.

The need for parallel replication reminds me of the first Bell’s Theorem experiments, wisely done in parallel for a coauthored paper (CHSH). The first experiment by Holt disagreed both with KQED and with Einstein’s expectations. I will never forget the expression on the face of my classmate Holt when he told me about that, on that day. “Will anyone ever accept this? Will I ever get my PhD?” It is great for the integrity of science that the difficulties in the early work were eventually documented, if not fully explained.

Because of these practical social considerations, I urge any experimenters in this field to begin with a high precision variation of the classic Bell’s Theorem Experiment (phase 1), to begin publication then (perhaps coauthoring with me at least for background and some theory inputs), and then going to phase 2.

2.1. Proposed Phase 1 Experiment

Phase 1 would be a higher precision variation of the standard SPDC Bell’s Theorem experiment. The usual version, reviewed in [9], is illustrated in Figure 2:



Figure 2. Core structure and notation for first Bell’s Theorem experiments

Again, this entire apparatus can now be purchased from the company qutools, along with computer support and controls required. The Source is a source of two entangled photons, coming out of a nonlinear crystal pumped by a laser. The photons have precise known frequencies, which I will now refer to as ν_L and ν_R . (For this paper I will not use the γ variables discussed in [9].) The polarizers are simple linear polarizers, tuned to pass through photons polarized to the angles θ_a and θ_b respectively. The output to be measured is $R_2(\theta_a, \theta_b) / R_0$, where R_2 is the rate at which photons are detected at both counters and R_0 is the rate at which photon pairs are emitted from the source. In the early experiment by Holt, the polarizer was a polarizer based on a calcite crystal with a special geometry, used to send photons of the orthogonal polarization off into limbo (absorption). Before beginning the Phase 1 experiment, I recommend doing the traditional experiment first.

For the new more precise experiment, the Phase 1 FTL experiment, see Figure 3 below. First use the same source from the traditional experiment, but purchase two calcite crystals to replace the calcite polarizers. But two new counters, so that you can record photons coming out which were orthogonal to θ_a and θ_b . (Both KQED and MQED agree that only photons with these orientations will emerge, to significant probability.) This is already more precise than the usual experiment, because it does not require estimates of R_0 , and it gives measurements of all 4 joint counting rates R_2 for different counting rates, which should agree with KQED and MQED both. (Same predictions). The color filters go further to reduce the rate of noise from stray photons.

To reduce stray noise even further, I propose in the final stage that you insert a black curtain around the left polarizer and counters, with a pinhole letting in light only from the source.

At each step, as you add first the new counters and polarizers, then color filters, then curtain, the noise should go down still further, allowing agreement with KQED far more precise than any experiment ever done before by orders of magnitude. That should be publishable in itself, and should not be risky to the graduate student doing the work, if that is who does it.

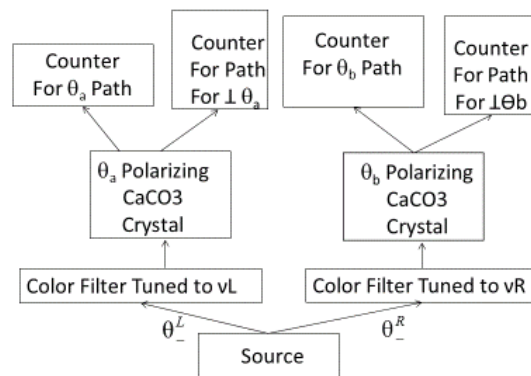


Figure 3. Phase 1 experiment for FTL demo

2.2. Proposed FTL Demonstration

To perform the core FTL experiment, simply replace the two “b” channel detectors in figure 3 with two incandescent light bulbs, as shown in Figure 4. These should be light bulbs controlled by dimmer switches, so that the emission and absorption rates at the frequency νR are different as the dimmer switches tune one bulb to a filament temperature of T_1 or T_2 .

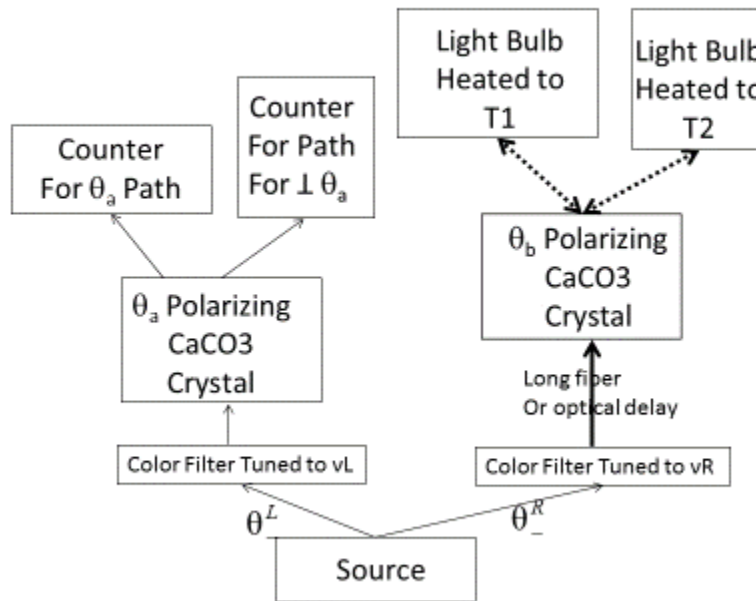


Figure 4. Proposed FTL Demo

For the initial experiment, use of a long fiber (maybe 1 meter or so) is not really needed. It is mentioned, because it allows a clear guarantee that the dimmer switch settings on the right can change the ratio of detections on the two channels on the left, in a way which implies communication of information faster than light and backwards through time. In KQED, the detection rates on the left should not depend at all on T_1 and T_2 ; if they do, this is already decisive, even if θ_a and θ_b are fixed in the experiment. On the other hand, if the ratio of counting rates between the two channels on the left is unchanged as T_1 and T_2 are changed, at dimmer switch settings with high enough output at color νR , for different settings of θ_a and θ_b , MQED fails.

It is hoped that the initial experiment should quickly rule out KQED or MQED, and support continued testing of the winner. In principle, if both are refuted, then there would at least be data opening the door to a new, third type of measurement model, which we would then discover we need to develop.

To understand this experiment intuitively, and predict more exact details, it is easiest to use the biphoton picture published by Klyshko [24], which supported the design of the first SPDC Bell experiments [25]. In that picture, a photon is sometimes emitted from the T1 light bulb, which by its location results in a photon of linear polarization θ_b going backwards in time, “bouncing” off the source as if from a mirror, and generating probabilities on the left as would be seen if the left channel source were just a flash light passing through a θ_b polarizer before reaching the θ_a crystal. Likewise, a photon is sometimes emitted instead from the T2 lightbulb, resulting in a photon backwards through time at polarization orthogonal to θ_b , leading to a different ratio of probabilities on the left (except for a few pathological choices for θ_a and θ_b).

3. Summary and Conclusions

As discussed in the abstract, the main purpose of this paper is to propose an important new experiment, which is complementary to (not an alternative to) the experiment proposed in [9]. The importance of these experiments to fundamental physics should be self-evident from the review above. It is time now to just go ahead and do the physical work. The experiment proposed in [9] is cleaner and more decisive from the viewpoint of theory, but the new proposal should be easier and should open the door to an even wider range of new technologies [22] --but it would be premature to say more about the possibilities before the empirical results are in.

If the experiments support MQED and time-symmetric physics in general, it also makes sense again to search as well for a more fundamental theory of physics for which MQED would be just an approximation [19]; however, the details are beyond the scope of this paper.

References

- [1] Jonathan P. Dowling, Gerhard Klimeck, Paul Werbos, *Final Report on ECCS/NSF Workshop on Quantum, Molecular and High Performance Modeling and Simulation for Devices and Systems (QMHP)* [arXiv:0709.3310v2](https://arxiv.org/abs/0709.3310v2)
- [2] J. Schwinger, ed., *Selected Papers on Quantum Electrodynamics*, Dover, 1958.
- [3] Mandl, Franz. *Introduction to quantum field theory*. New York: Interscience, 1959.
- [4] N.N.Bogolyubov & Shirkov, *Intoduction to the Theory of Quantized Fields* (Chomet tr.), Wiley 1980. See also N.N. Bogolyubov, *General Principles of Quantum Field Theory* (Gould tr.), Kluwer Academic, 1990
- [5] Weinberg, S., [1995] *The Quantum Theory of Fields.*, Cambridge
- [6] Supriyo Datta, *Quantum Transport: Atom to Transistor*, Cambridge U. Press, 2005
- [7] Hooft, Gerard T. "The Cellular Automaton Interpretation of Quantum Mechanics." *arXiv preprint arXiv:1405.1548* (2014).
- [8] P. Werbos, review of [7], <http://drpauljohn.blogspot.com/2017/07/back-to-reality-review-of-book-by-lead.html>
- [9] Werbos, Paul J., and Ludmilla Dolmatova. "Analog quantum computing (AQC) and the need for time-symmetric physics." *Quantum Information Processing* 15.3 (2016): 1273-1287. Posted at www.werbos.com/triphoton.pdf.
- [10] Serman, George. *An introduction to quantum field theory*. Cambridge University Press, 1993.

- [11] Glimm, J. and Jaffe, A *Quantum Physics: A Functional Integral Point of View*. New York: Springer, 1981; J. Schwinger, *Particles, Sources and Fields*, Addison-Wesley, 1970; J. Schwinger, *Particles, Sources and Fields*, Volume II, Addison-Wesley, 1973.
- [12] Werbos, P.J. [2008] "Bell's theorem, many worlds and backwards-time physics: not just a matter of interpretation." *International Journal of Theoretical Physics* 47.11 (2008): 2862-2874. (open access)
- [13] Yamamoto, Yoshihisa, Francesco Tassone, and Hui Cao. *Semiconductor cavity quantum electrodynamics*. Vol. 169. Springer Science & Business Media, 2000.
- [14] Carmichael, Howard J. [1999] *Statistical Methods in Quantum Optics I: Master Equations and Fokker-Planck Equations*. Berlin: Springer, 1999; Carmichael, H. J. [2007], *Statistical Methods in Quantum Optics 2*, Springer, New York
- [15] Dutra, Sergio M. *Cavity quantum electrodynamics: the strange theory of light in a box*. John Wiley & Sons, 2005.
- [16] Werbos, P. J. "An approach to the realistic explanation of quantum mechanics." *Lettere al Nuovo Cimento (1971-1985)* 8.2 (1973): 105-109.
- [17] Bell, J.S. [1987], *The Speakable and Unsayable in Quantum Mechanics*, Cambridge U. Press
- [18] Werbos, P. J. "Bell's theorem: the forgotten loophole and how to exploit it." *Bell's theorem, quantum theory and conceptions of the universe*. Springer Netherlands, 1989. 81-83.
- [19]. P. Werbos, *Preliminary Evidence That a Neoclassical Model of Physics (L3) Might Be Correct*. Vixra.org>Mathematical Physics>viXra:1704.0264
- [20] Steven F. (ed), *Time's Arrow Today: Recent Physical and Philosophical Work on the Arrow of Time*, Cambridge U. Press, 1997
- [21] P. Werbos, preliminary results on all-angles triphoton attempt based on thermal light, <http://drpauljohn.blogspot.com/2016/02/new-experiment-as-important-as.html>
- [22] Werbos, Paul J. "New technology options and threats to detect and combat terrorism." *Identification of Potential Terrorists and Adversary Planning: Emerging Technologies and New Counter-Terror Strategies* 132 (2017): 34. Also posted at http://www.werbos.com/NATO_terrorism.pdf
- [23] <http://drpauljohn.blogspot.com/2017/01/proposal-for-simple-experiment-to.html>
<http://drpauljohn.blogspot.com/2017/02/example-of-fundamental-basis-of-free.html>
- [24] Klyshko, D.D., *Photons and Nonlinear Optics*, Gordon and Breach, New York, 1988.
- [25] Rubin, M.H., Klyshko, D.N., Shih, Y.H. and Sergienko, V., *Phys. Rev. A*, vol. 50, 5122 (1994)