Bh

Non spin based quantum information transmission methods

Most physicists claim that no instantaneous communication (faster than light communication) between two distant points in space is possible in any manner.

This claim is originated in the no communication theorem[1], a no go theorem which states that if say Alice and Bob have two entangled systems set apart, no measurement that Alice can make can be detected by any measurement that can be made by Bob.

Another source of this claim is that apparently superluminal communication is inconsistent with special relativity. Superluminal (instantaneous) communication is, as its name implies, superluminal, and by so breaking light speed barrier imposed by special relativity.

A far more complicated apparent inconsistency with special relativity is the question of the equivalence between inertial observers[2]. Instantaneous communication from the point of view of one inertial observer is not instantaneous from the point of view of another. If the communication is instantaneous, apparently one observer is 'right' about his description of the system, while the other one is 'wrong', contradicting special relativity that claims all inertial observers have an equally valid view of the system.

According to the no communication theorem, quantum observation and measurement in entangled systems cannot be used not only for superluminal communication, but for any form of communication at all.

The no communication theorem produces a condition sufficient so that no instantaneous information transfer can result from a distant intervention (the term intervention well defined in the paper quoted in comment 1). The condition is that $[A_{\mu m}, B_{\nu n}]=0$[3], as A and B are Krauss matrices for the observations of outcomes "μ" by Alice and "ν" by Bob (Krauss Matrices well defined in the paper quoted above), as $A_{\mu m}$ are Alice's operators and $B_{\nu n}$ are Bob's operators.

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[1] Peres, Asher, and Daniel R. Terno. "Quantum information and relativity theory." *Reviews of Modern Physics* 76.1 (2004): 93.

[2] A very thorough discussion can be found in: Maudlin, Tim. *Quantum non-locality and relativity: Metaphysical intimations of modern physics*. John Wiley & Sons, 2011.

[3] Paper mentioned in comment 1, under the headline "The no communication theorem".

As shown by Peacock[4], This condition is only valid if non-local interactions don't exist. If Bob's Krauss matric *can* instantaneously be altered by an action made by Alice then this condition does not impose a barrier on instantaneous communication.

Now, let's take a careful examination of the no communication theorem and the barrier it lays in front of quantum (and by so instantaneous) communication.

The theory's claim is that any measurement made by Alice cannot be detected by any measurement that Bob can make, when both these systems are entangled. However, the term measurement is not yet well defined. This paper's claim is that in the no communication theory, the definition of a measurement is the obtaining of information about a system by using a well-defined operator (definition 1). If information about Bob's system was obtained by Alice but no operator was used by her, or an operator was used on Alice's system, but no information was gained by Alice on Bob's system, this paper claims that a measurement wasn't made and therefor the no communication theorem doesn't deny quantum communication for such processes.

Let's try proving this claim by giving examples of these two 'partial measurements'.

An example of gaining information on a system without using an operator is the use of the wave function's collapse. It is well known that no mathematical operator can describe the wave function's collapse, but rather, the collapse of the wave function is an experimental result added to quantum mechanic's equations, an addition that does not come naturally from quantum mechanic's formulation.

If Alice can cause Bob's wave function to collapse, then Bob's Krauss matric will change instantaneously (as we believe wave functions collapse instantaneously).

However, no well-defined operator was used in this case as the collapse of the wave function is not a well-defined operator as mentioned above, and therefor if superluminal communication is possible in this manner it will not be a violation of the no communication theorem. The condition $[A_{\mu m}, B_{\nu n}] = 0$ wasn't satisfied since Alice’s operators $A_{\mu m}$ are not well defined[5]. This is consistent with definition 1, as

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[4] Peacock, K.A.; Hepburn, B. (1999). "Begging the Signaling Question: Quantum Signaling and the Dynamics of Multiparticle Systems". *Proceedings of the Meeting of the Society of Exact Philosophy*.

[5] The operator $A_{\mu m}$ may be well defined. However the operator wasn't the cause of the collapse of the wave function as the collapse of the wave function is not a mathematical outcome of an operator. Bob's Krauss matric was affected by another "operator", not just $A_{\mu m}$, which caused the wave

Alice gains information on Bob's system without using an operator, and by so not performing a measurement on Bob's system according to the no communication theory.

This is in spite of Alice having full information about Bob's current system.

Asher Peres acknowledges this fact, but states, "A quantum jump is something that happens in our description of the system, not to the system itself[6]".

In Peres' view, the idea of communication using the collapse of the wave function is an absurd, as the collapse of the wave function and even the wave function itself is not a physical entity but rather it is just a way for us to describe a system. We cannot transmit information by using ways to describe our systems.

Interesting enough, Peres' claim can be phrased in the other direction as well. If the collapse of the wave function *can* result in instantaneous information transmission, then the collapse of the wave function *is* a physical entity, as again, we cannot use nonphysical entities to transmit information.

Now, let's examine what will happen if an operator was used on Alice's entangled system, but no information was obtained by Alice on Bob's system. For example, if Alice measures the momentum of the particles in her system and Bob measures the position of the particles in his system. In this case, Alice has no information about the position of Bob's particles as she measured momentum. Bob had just measured position of particles in his system, and therefor Alice's information about the momentum in Bob's system is now ruined. Alice now knows nothing about Bob's system.

However, in this case $[A_{\mu m}, B_{\nu n}]$ doesn't equal 0, as these two observables sustain an uncertainty principle's relations between them, and therefore the commutation $[\hat{x}, \hat{p}]|\psi\rangle = i\hbar|\psi\rangle \neq 0.$ The no communication theorem's condition wasn't satisfied. Again, if we can find a way of communication between entangled systems using the uncertainty principle as shown above, this will not be a violation of the no communication theorem. This is consistent with definition 1, as even though an operator was used by Alice, according to the no communication theorem no measurement was made and therefore the no-communication theorem doesn't prohibit quantum communication for such processes.

In conclusion, the no communication theorem denies Alice from making any *measurement* on her system observable by any *measurement* made by Bob on his system. But, the term measurement must be well defined.

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function to collapse. This "operator", being not well defined, doesn't satisfy no communication's condition.

[6] Quote from the paper mentioned in comment 1.

Acknowledging the above, let us now offer two ways of quantum based communication using the collapse of the wave function and the uncertainty principle, which as mentioned above do not defy the no-communication theorem.

Say Alice and Bob are ten light years away from one another. Mo, 5 light years away, shines 600 photons through a beam splitter, which enables the photons to travel in two separate ways A and B. After the split, in both ways A and B, stands a BBO. The photons then pass through the BBO[7] sending a photon to Alice and a ghost photon to Bob. The photons sent to Alice will form an interferometry pattern on Alice's screen. However, the photons sent to Bob contain "which way information". This means that by measurement, Bob can know which way the photons in Alice's system chose to pass through. Such a measurement will cause the interferometry pattern in Alice's system to disappear.

Now, Bob receives the photons just a short while before Alice, 10 light years away.

Bob now has choice to either measure the information or erase it.If Bob chooses to erase the information in his system using a quantum eraser[8] , Alice will receive an interferometry pattern on her screen. However, if Bob chooses to measure the "which way information" contained in these photons, no interferometry pattern will be shown on Alice's screen. Such a message can be sent in a time significantly shorter than ten years.

This experiment can be conducted in a laboratory, and can prove quantum communication through entangled particles is possible. Proving superluminality in this case is more difficult. However, there is good reason to believe that if quantum entangled systems can be used for communication, the communication will be superluminal.

Another method of quantum communication not defying the no-communication theorem is if Alice and Bob have two entangled systems containing 600 particles each (total 1200 particles, 300 of Bob's particles entangled with 300 of Alice's particles called system A and 300 of Bob's particles entangled with 300 of Alice's particles called system B) again, 10 light years away. Bob knows the expected mean of finding his particles in both systems around a center C. Alice measures momentum in one of her systems (system A) with high 'precision', and measures momentum in the other system (system B) with low 'precision'. Bob now measures location of each particle in both of his system, in the same manner exactly.

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[7] For better understanding of the terms BBO, SPDC etc.: Strekalov, D. V., et al. "Observation of two-photon “ghost” interference and diffraction." *Physical review letters* 74.18 (1995): 3600.

[8] For a better understanding of quantum erasers: Scully, Marlan O., and Kai Drühl. "Quantum eraser: A proposed photon correlation experiment concerning observation and" delayed choice" in quantum mechanics." *Physical Review A* 25.4 (1982): 2208.

Now, Bob can measure the standard deviation **σx** in both of his systems. The one measured with high precision by Alice, will have a higher **σx**, and the one measured with low precision will have a lower **σx**, according to the uncertainty principle $\sigma_x\sigma_p \geq \frac{\hbar}{2}$. Bob now knows which system was measured by Alice with high precision. This qualifies for communication[9].

This applies to many systems that have uncertainty relations between them, not just momentum and position. This method can be tested in a laboratory.

The two methods mentioned above, if enables quantum communication, do so without inconsistencies with the no communication theorem according to definition 1. However if the communication is instantaneous, inconsistencies with special relativity haven't yet been ruled out.

First, instantaneous communication is the transfer of information in a superluminal manner, meaning faster than the speed of light. This is contradictory to special relativity's postulate that nothing can transfer faster than light.

However, in both cases stated above, the superluminal connections were prior to our measurements. After making a measurement, whether we use the collapse of the wave function or the uncertainty principle, no superluminal communication is possible as long as the measurement remains valid.

The special relativity theory had been proven correct in countless experiments, but by definition, all of them where post measurement. We don't know, or can't know,

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[9] Werner Heisenberg stated that the more precisely the position of some particle is determined, the less precisely its momentum can be known, and vice versa: Heisenberg, W. (1927), "Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik",*Zeitschrift für Physik* **43** (3–4): 172–198, Bibcode:1927ZPhy...43..172H, doi:10.1007/BF01397280.. Annotated pre-publication proof sheet of Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik, March 23, 1927.

Alice's distant measurement affected Bob's measurements in some manner. One may ask why this is different than spin based quantum entangled measurements, where the connections from afar are undetectable by measurement. The answer is that spin based measurements don't change the inner relations between the results in the same system. Therefore, spin measurements cannot be detected. However uncertainty based measurements alter the inner relations between measurements in the same system, and therefor can be detected by comparison of inner results between two systems ensemble differently, as in this case the different treatment to each system was made from afar.

how a physical system behaves before we measure it. We don’t know if it obeys special relativity or not. All we know is that every system, once measured, obeys special relativity to its full extent, and likewise every other physical law discovered.

Therefore, we can state that no physical system has ever defied special relativity once measured. Prior to its measurement, we can't state and base our statements on experience that the physical system is bound to relativity. These "Spooky connections from afar" noted by Einstein are all prior measurement connections, and therefore impose no 'threat' on the validity of special relativity.

This is not a uniqueness of special relativity, but a general attribute of physical systems. Systems behave differently prior to their measurements. For example, the tunneling effect proves a particle can jump over a potential barrier and by so apparently violating energy conservation law. However, this violation occurred before our measurement. After our measurement particles behave classically, and obey rules of physics.

However, there is a more serious apparent inconsistency with special relativity.

For example, say Alice and Bob chose the first method of superluminal communication.

Alice and Bob are both standing in a very long train traveling close to the speed of light. An observer standing on this train watches their experiment and states that Bob made a measurement on his system causing the wave function of Alice's system to collapse. Afterwards, Alice made a measurement and found that in her system the wave function had collapsed.

This observer has no questions about the physical process that took place. Bob's measurement made Alice's wave function to collapse, and Alice measured it afterwards.

However, an observer standing on the dock may tell a different story. He may state that Alice first made a measurement and found that the wave function in her system had collapsed, and only afterwards, Bob had made his measurement. But if that is the case, what made Alice's system collapse? It surely wasn't Bob's measurement that came after Alice's measurement. This observer will have to conclude that in his system wave functions tend to collapse with no apparent reason, and by so violating the first postulate of special relativity - Laws of physics are invariant in all inertial systems.

In order to keep superluminal communication consistent with private relativity, we must broaden the symmetry of special relativity to past/future symmetry.

It must be that physically, there is no difference between the two observers, meaning that there is no physical difference if Bob first made the measurement and then Alice made hers or the other way around.

If it is definite that the system will be measured, then it is as if it was already measured, and therefore both descriptions of both observers are valid. In other words, the future effects the past. If it is certain that a system will be measured in the future, it is as if the system was already measured in the present, and therefore results will be similar.

We might want to ask *when* exactly the wave function collapsed in Alice's system.

Such a question will be hard to answer as we cannot 'see' or measure wave functions and by so know exactly when they collapsed. But the wave function collapsed before the photons hit the screen, as a result of a measurement made *after* the photons hit the screen.

This conclusion that future effects past is a little new to our intuition. It is not absolutely new however, and was mentioned by John Wheeler [10] and by Scully and Druhill[11] in different experiments.

It is however a new in the sense that future measurements alter past's measurements results, not only the interpretation of them.[12]

This however can be checked to somewhat extension in a laboratory. We know that, in experiments that the "Which Way" information exist[13], the mere existence of the information causes the wave function to collapse. Otherwise, we can always measure the "Which Way" information and find which path the photon chose to take. However, what will happen if the "which way" information exists, but we have no physical ability of measuring it? We can design an experiment that will show that in this case the system will behave as if the information was already erased, from the moment we have no physical possibility of measuring the system and forward. This is because the fact that the system will not be measured in the future affects measurements made in present, as if the information was erased.

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[10] Wheeler, John Archibald. "Genesis and observership." *Foundational Problems in the Special Sciences*. Springer Netherlands, 1977. 3-33.

[11] Scully, Marlan O., and Kai Drühl. "Quantum eraser: A proposed photon correlation experiment concerning observation and" delayed choice" in quantum mechanics." *Physical Review A* 25.4 (1982): 2208.

[12] The concept of future effecting past isn't new in quantum mechanics, as shown above. However, both in Wheelers experiment and in Scully and Druhl's, the experiment was made in the present and the results shed 'different light' on what happened during the course of the experiment, in the past. In this case, future measurement determines presents results.

[13] The term "Which Way information" very well explained in the papers mentioned above.

If the "which way" information exists, yet it is about to be measured, and we have no physical possibility of preventing this measurement, the system will behave as if a measurement was made and no interferometry pattern will appear on our screens.

This experiment however is slightly different than the one described above. In this experiment we *don't have* the physical possibility to measure the "which way" information. According to the observer on the dock, If Bob chose, for example, not to measure the information, an interferometry pattern will appear on Alice's screen. The order of events might be according to him: Alice receives an interferometry pattern, then Bob has the choice whether to erase or to measure his system, then Bob decides to erase his system.

However, in our systems, as long as Bob *can* measure the system, it is as if the system *was* measured and no interferometry system will appear on Alice's screen.

This is an apparent inconsistency, as if from the observer on the train's point of view the order of events will be similar, i.e. Alice receives a pattern on the screen, Bob thinking whether to erase or measure the information, and then Bob decides to erase the information, Alice will receive no interferometry pattern on her screen, since as long as Bob has the option to measure his system he might do so, and if Alice receives an interferometry pattern and later Bob receives the "which way" information, this leads to a paradox.

Since laws of physics should be consistent in every inertial system, such an order (Alice receives, Bob thinking, Bob erases) should produce same results for both observer on the dock and observer on the train.

This may be caused due to freedom of choice. As long as Bob has freedom of choice to measure the system, it is as if he measured it, since the fact that he can measure it may result in the fact the he *will* measure his system, and if an interferometry pattern appears and Bob later measures the system, this will be a paradox, something which the universe refrains from doing.

However, in the example of the train, Bob had no freedom of choice and he couldn't measure the system, in the eyes of the observer on the dock, since in the eyes of the observer on the train which are valid similarly, Bob has already chose not to make a measurement but to erase it.

Our lab experiments will probably show that if the order was that first Alice receives a pattern on the screen, then Bob thinks whether or not to measure the information, then he decides to erase the information, probably no interferometry pattern will be shown on Alice's screen. However, our experiments aren't preformed on a long train with an equally valid observer in the train, which in his eyes the outcome of the experiment had already taken place and therefore we as observers on the dock state that the experimenter had no freedom of choice.

It is only in the eyes of the observer on the dock that Bob has no freedom of choice but to erase the information. In other words, **the question 'does Bob have freedom of choice' effects the results discovered in a lab.**

As mentioned earlier, Peres' statement that no superluminal communication is possible, and that the collapse of the wave function is not a physical entity but a method for us describing our system, can be phrased the other way around. If we can use the collapse of the wave function to transmit information, maybe the collapse of the wave function is not just a way of describing our system, but represents a physical entity.

In other words, if the compatibility between two distant entangled systems enables any form of communication, then the compatibility between these two systems were caused by a physical entity, and we must understand how exactly does it behave.

It seems as if there is some kind of connection between the two entangled distant particles, a connection which is instantaneous, and represents a physical entity.

But how can one particle correlate with another through vast distance in zero time?

The simplest answer is, prior to its measurement (or to the certainty of it being measured) a particle of some kind travels with an infinite speed and reaches the other particle and transmits information to it.

Since this sounds as the simplest answer, let's try to discuss the behavior of such a particle, that is, a particle moving with infinite speed.

First, a particle with infinite speed cannot travel without oscillation. If it travelled in one direction without oscillating, in zero time it would reach the end of the universe and we could never measure it. Therefore some form of oscillation must take place.

Now, an infinite speed oscillator oscillating between two points A and B, is the model that we are investigating.

What would its properties be? How would it behave?

Of course, we cannot predict where we will find this particle once we've made a measurement. It can be in any point between A and B. Even if a very short moment ago we somehow know it was in point A, it can now be anywhere between point A and point B.

If the oscillating particle is harmonic, then there is an equal chance of finding the particle in any point between A and B.

However, if the movement of the oscillator changes over time, or over space, the chances of finding the particle vary with the change.

For example, if the particle oscillates between A and C, and every X times(X represent an infinite number of some magnitude, not yet well defined) that the particle reaches C, it proceeds to point D and returns to point A, the chances of finding the particle between A and C are probably larger than finding it between C and D, Even though its speed is infinite. This claim is intuitive, however it yet needs to be proven mathematically. Intuitively we can understand that there is a higher chance of finding the particle between two points that its more "present" in than between two points that it is "less present" in.

Now, let's ask, what is the location of the particle prior to its measurement? Well, the only answer that can be given is that the particle is "all over" the space between A and C.

This sounds very much like a wave (or a string), as it is simultaneously "all over" a certain space. If the oscillation is two dimensional, we can describe this prior measured particle as a two dimensional wave front.

This of course sounds similar to the "wave/particle" duality which is imposed by quantum mechanics.

But now, what happens when we measure for instance the particle's location? As mentioned earlier, as long as the measurement is valid, nothing has ever shown to violate special relativity's speed of light barrier after being measured. Therefore, after being measured, the particle will have to obey special relativity and its speed must from now on be sub-luminal, i.e. smaller than the speed of light.

But if it's speed is smaller than the speed of light, then immediately it loses its 'wavelike' behavior, and behaves from now on as a particle (!).

This of course is due to the fact that the "wave like" behavior was caused by the particle's oscillation in infinite speed.

In other words, the particle only behaves like a wave when it oscillates in infinite speed, and after it's measurement it can't oscillate in infinite speed because that will violate special relativity, therefor after the measurement it will behave like a particle, and not like a wave.

This behavior sounds very much similar to the collapse of the wave function, with the wave function collapsing after measurement.

Of course, an important question is yet to be answered, what is the importance of the measurement that imposes the system to accept special relativity?

A possible direction could be that the measurement only reveals a part of reality that we can measure. Another direction can be that the measurement affects our experiment. This yet needs to be decided.

In conclusion, we see that adopting the idea that particles can move in an infinite speed prior to their measurement yet obeys special relativity after being measured can explain not only the correlation between entangled distant particles, but also some fundamental principles of quantum mechanics, such as the question of probability, the wave\particle question, and the collapse of the wave function during measurement.

Not only prior measurement superluminal traveling of the particle doesn't contradict special relativity, but special relativity explains the observed 'collapse of the wave function'.

Now, it is important to find some predictions or some experiments that can prove that the wave function prior to its measurement is a physical entity, with physical effects.

In plain words, we want to prove that the photon *really* passed through both slits and left a detectable trace in both of them.

Let us describe some photons shined on a beam splitter and split up to two paths A and B. Both parts of the split photon find a BBO sending a ghost photon to interact with the other ghost photon on a second screen and form an interferometry pattern. The two parts of the original split photons continue to the screen to form an interferometry pattern on the screen. After many photons shone we can see interferometry patterns on both screens.

This means that every photon passed through both slits simultaneously affected both BBO's before it was measured. The interferometry pattern formed on the main screen proves that no measurement was made and wave function didn't collapse.

The interferometry pattern on the second screen proves that both BBO's were involved in the process simultaneously and formed the interferometry pattern. This, if true, proves that prior measurement the wave function *is* a physical entity that affects reality, and that it *is* present in both paths A and B.

To emphasize this point, let's think of another version of this experiment.

In this experiment we place two detectors measuring for instance the energy of the photon that passed through a double slit. Of course, if we place one detector, this detector might 'give out' "which way" information and cause the wave function to collapse.

But what happens if we place two detectors, one after every path that will measure the energy carried by the photon[14]?

In this case, since we have no 'which way' information, the wave function may not collapse. Moreover, it is possible that both detectors (placed far away from one another) may detect energy, yet not absorb the entire photon, and the "remaining" of the split photon will continue to a screen and form an interferometry pattern on this screen.

This will prove that energy was transmitted by this photon while it was still in the form of a 'wave function', which caused the interferometry pattern to appear on the screen.

This if true will prove that the wave function carries energy even in its prior measurement form, as a wave function, as the interferometry pattern shown on the screen will prove that the photon was still in its ‘wave like’ form while giving energy to the detectors.

Finally, another cardinal question must be made, which is what is unique about special relativity that it and only it is broken prior to our measurements? Do the rest of the laws of physics still apply to the system, while the speed of light barrier is broken?

I believe the answer is no. I believe that there is nothing special about the violation of special relativity prior to making the measurement. I believe many of the laws of physics are violated prior to the measurement as well.

Let’s examine for example the experiment mentioned above, with two energy detectors placed after the beam splitter, an energy detector in every course that the photon may choose.

We might think that if the initial energy of the photon was E, then the maximum energy that can be absorbed by each detector may be E/2, or maybe even, in the case of the collapse of the wave function for instance, one detector will absorb E energy and the other will absorb 0.

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[14] In order to make sure that no "which way" information was obtained during the experiment, precise measurements of momentum must be made. The energy of the photons can be derived from the precise momentum measurements.

This thought comes from our understanding of the wave function as a function of probability of finding a certain energy value in a certain measurement.

However, our measurements cause the collapse of the wave function. But if the wave function represents a true physical entity even prior to its measurement, it may be that we could use the wave function itself, $\psi(x)$ (probably the real part of it) and not only the real valued function $|\psi(x)|^2$, to describe the prior measured system's behavior.

If this is true, we may receive for example a positive energy value for one detector, and a negative energy value for the other, as the energy operator may remain

$$\hat{E} = i\hbar\frac{\partial}{\partial t} .$$

We have no reason to believe according to the interpretation mentioned above that prior to its measurement a wave function will behave in a deterministic manner.

The behavior will probably remain probabilistic, as the main difference between prior measured wave functions and post measured one is the use of the original wave function in order to determine probability of effects that the wave function has on other systems (measured without causing the wave function to collapse), while post measured systems give probabilistic results of measurements by their real valued function $|\psi(x)|^2$.

This however may be very difficult to test in a lab, as if for example there is a 50% chance for each photon to pass through course A and 50% of passing through course B, it may come out that we cannot control which detector will receive the positive energy and which will receive the negative one.

This process may be completely random, and by so not breaking energy conservation on a large scale, as the positive energy contributions and the negative ones reduces one from the other.

Moreover, it can be found that after many photons had passed through both detectors, no energy was absorbed by the detectors due to prior measurement wave functions as the positive energy contribution was nullified by the negative one.

It can be however that if all photons that had passed through both detectors are entangled, then maybe the positive contribution will be consistent and so will the negative one be.

In other words, if all photons shone through the beam splitter are entangled, it is possible for example that if the positive contribution by the first photon was absorbed by the detector in course A, and the negative contribution was absorbed by the detector in course B, then all of the entangled photons will contribute energy in the same manner, positive energy to detector in course A and negative energy to detector in course B[15].

This could be tested in a lab a little bit more easily, as the detectors don't have to be sensitive enough to detect the effect of a single photon and analyze it.

However, entangling many photons and shining them all through a beam splitter towards two detectors might turn out as a technical challenge.

In conclusion, violation of physical laws is a property of wave functions that isn't specific to special relativity. Rather, the physical world may behave differently; respond to different equations, and moreover different logic, prior to its measurement.

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[15] The resemblance of this energy to the famous 'dark energy' does exist, as this may turn in to a large energy source that by definition cannot be measured or detected as such a measurement may cause wave functions to collapse. Caution is needed however as many questions about this energy remain veil.