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Communication theorems

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Abstract:

It has been stated time and again that up to date, superluminal communication is beyond our reach. But, is superluminal communication an impossibility or an improbability? Observing current No Communication Theorems (NCT) one must conclude that it is a mere improbability, and that communication may be possible in the future.

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1. No Communication Theorems:

Mostly, no communication theorems are based on the following logic: As Alice and Bob want to communicate with one another, as Bob holds one part of a bi-partite system and Alice holds the other, no operator that can be used by Bob can change the probability of the any outcome measured by Alice.

An example of such a theorem can be found in Asher Peres': "Quantum Information and Relativity Theory" [1].

It is stated that if:

$$[A\mu m, B\nu n] = 0$$

As $A\mu m, B\nu n$ are Kraus Matrices for observation of outcomes μ by Alice and ν by Bob, then the probability of Bob receiving a result ν irrespectively of Alice's results is, after some simplification:

$$\mathrm{p}(\nu) = \mathrm{tr}(\sum_{n} B\nu n\, \rho\, B * \nu n)$$

In other words, Bob cannot from afar effect in any way the probability of an outcome received by Alice, therefore communication is not possible.

This logic however must be questioned. The original EPR [2] paper never claimed that one can affect from afar *any* outcome of another observer. The claim was that non-local correlations are present between the outcomes of two distant observers.

Communication Theorems:

Therefore, a no communication theorem must pre-eliminate the possibility of effecting distant correlations between outcomes, rather than the outcomes themselves.

Such a theory hasn't been presented. Contrary; in a standard Bell experiment [3], if Bob and Alice, distant from each other, both hold a detector, Bob can from afar alter the probability of a coincident detection.

It is just that in a bipartite quantum system such actions cannot create communication, as in order to see correlations one must view both particles simultaneously, an action which demands locality.

However, in a 4 partite quantum system [3], viewing correlations between states is not necessary.

Consider the 4 partite quantum system :

$$a\ ((|0>|0>|0>|0>\ +|1>|1>|1>|1>)+b(|0>|1>|0>|1>+$$

$$|1>|0>|1>|0>$$

If a and b can be set by distant observers, than if for instance communication protocol begins by Bob setting b=0 and Alice sets a=1, then every fourfold coincidence registered by the coincidence counter must show a correlated entanglement.

If Bob receives for example two out of four photons and detector b, Bob can now alter b's value and a's value so now b=1 and a=0, resulting in complete anti correlations at Alice's detectors. Bob had sent a <1>.

Another communication theorem can be based the Ghost interference SHIH experiment [4]. It has been mentioned by JG Crammer and Nick Herbert [5] that in theory this experiment can be used for superluminal communication, however we don't know which photons to refer to, until this information is derived by classical means.

In this experiment two entangled photons experience "ghost interferometry", meaning that if one went through a double slit, the other one will show double slit interferometry patterns.

In order to identify the "reference" photons, we can send a multiple entanglement, half to Alice and half to Bob. Bob can pass his photons through a double slit, and Alice will receive interferometry patterns in her photons, given that she refers to them all combined. By using odd halves (3 out of 6 for example), Alice can reduce her SNR, as the probability of a random threefold coincident detection is rather low.

Relativity:

Special relativity holds that different observers in different reference frames may state that different occasions occurred in different times, following:

$$t' = ((t - vx) \div c^2)\gamma$$

According to observer O in reference frame R, an occasion X could have happened before occasion Y, as observer O' in reference frame R' may state that occasion Y occurred before occasion X.

If quantum signaling is an improbability rather than impossibility, or even as it may be possible, one must ask does it violate causality, meaning an effect may occur before its cause as shown above.

In order to state that quantum communication is not in contradiction with special relativity, we must suggest a new symmetry- a *future/past* symmetry.

In this symmetry, *a future event that is certain to occur had already occurred, and its implications can be seen in the present.*

Therefore, if Bob sent a signal to Alice by moving his detector, in reference system R Bob had first altered Alice's measurement, and then measured his own photons, and then Alice made her measurement.

In reference system R' first Alice made her measurement, then Bob altered the results, and then Alice made her measurements.

According to the *future/past* symmetry, Bob's future actions effects Alice present measurement.

This can be seen in an experiment.

Consider the SHIH Ghost interference experiment [4]. We can place a delay between the beam splitter and detector *f1.* In this case, the entangled o photon will reach detector *f2 before* the e photon reaches the double slit.

According to this symmetry the o photon will show double slit patterns despite the clear fact that the ghost interference *hadn't* yet occurred.

Summary:

Quantum communication is a possibility, yet obstacles must be removed in order to achieve it. But quantum communication proves that measurement, wave functions, collapse of wave function etc. are real physical entities. It must yet be researched how can we prove and use the classical nature of measured matter in favor of physics.

References:

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