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On No Communication Theorems

Omer Zvi Dickstein,

Department of Applied Physics, JCT, Jerusalem

Abstract:

No communication theorems apply if and only if Alice and Bob's Krauss matrices for the observations of Bob's separate outcomes and Alice's separate outcomes are commutative. We hereby suggest a situation in which Alice and Bob's Krauss matrices for the observations of Bob's and Alice's separate outcomes are not commutative, and therefore no communication theorem does not apply to it.

Contact: *omerzvid@gmail.com*

1. No Communication Theorems:

No communication theorems have a basic condition of commutation between Krauss matrices for the separate outcomes μ by Alice and ν by Bob.
If Bob's and Alice's Krauss matrices for separate outcomes do not commute, no communication theorem doesn't rule out communication between Alice and Bob.
For example, this had been mentioned by Asher Peres in: "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:

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

Communication Theorems:

An interesting case would be Krauss matrices for observations of outcomes μ by Bob and ν by Alice, as these matrices are from different dimensions.

For example, in case of three qubit entanglement, if Bob receives one qubit and Alice receives 2 qubits, Bob's Krauss matric for his observations will be in the order of 2x2, while Alice' Krauss matric of her observation will be of the order of 4x4. These matrices do not commute, nor even can they be multiplied, and therefore no communication theorems do not apply on any outcome received by Bob or Alice.

Intuitively, it is simple to understand that if Bob can affect from afar not the outcome of Alice's measurements but the correlations between his measurements and Alice's measurements, then if for example Alice receives 2 qubits and expects correlations between them, but Bob however set the correlations between his qubits and Alice's qubits so that one qubit will be in correlation with Alice's qubit and the other will be in anti-correlation with Alice's other qubit, then Bob had interfered with the outcomes received by Alice.

It has been shown above that this result is consistent with no communication theorem.

Intuitively, I believe, the original EPR paper [2] did not exclude the possibility of quantum communication.

[1] PERES, Asher; TERNO, Daniel R. Quantum information and relativity theory.*Reviews of Modern Physics*, 2004, 76.1: 93.

[2] A. Einstein, B. Podolsky, and N. Rosen, Phys rev. 47, 777 (1935).