Simple Superluminal Entangled Communication Scheme and Its Base of Special Relativity

Abstract: Based on quantum entanglement and corresponding quantum communication, we research a simple superluminal entangled communication scheme, whose key is to establish two mutually entangled particles or devices A and B. We observe and control the information of A position, then can know the corresponding results of the other B. This is not to send directly information each other. It may be superluminal. In special relativity we provided that there are necessary two symmetrical topological structures separated by the light-cone, which includes the generalized Lorentz transformation (GLT) for the spacelike interval, in which phase velocity is superluminal. It is base of this scheme, and may test GLT.
Key words: quantum entanglement, communication, superluminal, special relativity.

1. Introduction

Based on the Einstein-Podolsky-Rosen (EPR) correlations and Bell inequalities, first, Aspect, et al., realized EPR experiment by the measure on the linear-polarization correlation of pairs of photons emitted in a radiative cascade of calcium and time-varying analyzers, and it agrees with the quantum mechanical predictions and the greatest violation of generalized Bell inequalities [1,2]. Ghosh, et al., demonstrated the existence of nonclassical effects in the interference of two photons [3]. Further, the nonlocality and entanglements become not only the frontline in modern physics, but also caused wide discussion of quantum communication [4-10]. These have caused a heated debate. Aspect speculated that quantum entanglement would trigger a technological revolution. In this paper, we research a simple superluminal entangled communication scheme, and its base of special relativity, in which phase velocity is superluminal.

2. General Quantum Communication

First, Bennett, et al., proposed the quantum teleportation via dual classical information and nonclassical EPR correlations [4]. This basic method forms base of the quantum communication discussed widely. Then Bouwmeester, et al., investigated experimental quantum teleportation, in which an initial photon which carries the polarization that is to be transferred and one of a pair of entangled photons are subjected to a measurement such that the second photon of the entangled pair acquires the polarization of the initial photon. This latter photon can be arbitrarily far away from the initial one [5]. Pan, et al., realized experimentally entangled freely propagating particles that never physically interacted with one another or which have never been dynamically coupled by any other means [6]. Further, they researched entanglement and quantum communication [7,8].

Weihs, et al., observed strong violation of Bell's inequality in an EPR-type experiment with independent observers. This experiment the first time fully enforced the condition of locality, and the necessary spacelike separation of the observations is achieved by sufficient physical distance between the measurement stations, by ultrafast and random setting of the analyzers, and by completely independent data registration [9].

Gao Shan analyzed the relation between quantum collapse, consciousness and superluminal communication. Quantum collapse as result of quantum nonlocality may permit the realization of quantum superluminal communication (QSC) [10]. He introduced a possible mechanism of nonlinear quantum evolution and achieved QSC, which must exist based on the quantum nonlocal influence [11]. Walleczek, et al., discussed the apparent conflict between quantum mechanics and the theory of special relativity, and nonlocal quantum information transfer without superluminal signalling and communication [12].

The current quantum communication is restricted by quantum superposition and quantum collapse. So now quantum communication is not quantum entangled communication, but quantum encrypted communication, which is based on the BB84 protocol [13], which is quantum cryptographic distribution protocol, and uses the polarization state of photons to transmit information. And the basis of these is still the general quantum mechanics. Siddiqui, et al., proposed a new Quantum Key Distribution method, which provides an additional layer of security over the standard BB84 protocol [14].

So far, the basic entangled communication schemes proposed are mainly to establish direct relations between two entangled particles, and it is generally believed that there is not superluminal communication. For example, a typical method prepares a pair of entangled photons at the A, leaving the photon 1, the photon 2 sent to the B position. If A wants to send a message to B, it has to measure photon 1 and then tell B to make the measurement by means of classical communication.

In 2002, Bose and Home proposed that used sorter sends two entangled particles [15]. In 2021, Hao, et al., researched the entanglement-assisted communication surpassing the ultimate classical capacity [16]. Hu, et al., discussed long-distance entanglement purification for quantum communication, and pathways for entanglement based quantum communication [17,18].

Its important basis is that Enrique Galvez, et al., proposed a complete set of instruments to generate entangled photons in the laboratory, and the experimental process into a manual placed on the network [19].

3. Simple Superluminal Entangled Communication Scheme

Now we research that the theoretical method of entangled communication is to establish two mutually entangled particles or devices Alice (↑①↓) and Bob (↓②↑) (Fig.1). As long as observing the information of A position can know the corresponding results of the other B. The key is not to send information each other, but to observe-control self results, thus knowing another information and phase. It is

consistent with First Laser-Amplified Superluminal Hookup (FLASH) proposed by Herbert in 1982 [20], but which restricts by quantum mechanics. The experiment achieves the spacelike separation of the observations [9], and the corresponding superluminal phase velocity. While sending information, check-compare results in both places must depend on the intermediate station Cart ③, which is still the time-like interval, subluminal and Lorentz transformation (LT).

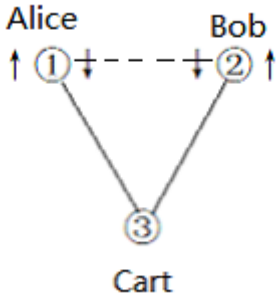

Fig. 1. Relations between three positions

Between A and B there is the nonlocal superluminal correlation and the phase velocity, which is a very predictable name. The relation between group velocity and phase velocity is the well-known de Broglie relation $v\bar{v}=c^2$. It is a post-processing. If continuous sending of different entangled particles to A and B, it will be confidential, and corresponds to constant modification of the key. The key difference is that involve not 3 groups of particles, but only a pair of entangled particles and a pair of entangled devices.

A pair of entangled states is generated on both positions, or preparing and transmitting a pair of entangled instruments, so the superluminal quantum communication can be realized. Thus encoding the states (different phases) to form two codes: yes or no, ↑ (positive) or ↓ (opposite), both correspond to 1 or 0. Manipulation for one position can pass the same message or information to the other, so we may implement the superluminal communication. If they are opposite (e. g. spin-polarization), for 110 at A, B will be 001. For example, two photons have well entanglement

$$|\Psi^-\rangle=\frac{1}{\sqrt{2}}(|0\rangle_A|1\rangle_B-|1\rangle_A|0\rangle_B). \qquad (1)$$

When A is $|0\rangle_A$, so B will be $|1\rangle_B$; when A is $|1\rangle_A$, so B will be $|0\rangle_B$. If both are the same (similar magnetic direction), A and B are two 110. Of course, they must be completely entangled.

For the signature r, let $r=e^{-i\pi\alpha}$, r=1 so the signature exponent α=0, r=-1 so α=1.

The main problem of entanglement communication is to overcome decoherence. Further, it develops to the corresponding information theory. From this, a popular

example is the telepathy between A and B.

4. Base of Special Relativity on Superluminal Communication

Based on the basic principles of the special relativity, according to the constancy of the velocity of light in the vacuum principle, it obtains invariance:

$$s^2 = r_{mn}^2 - c^2 t_{mn}^2 . \qquad (2)$$

In a time-space ($x_0 - x_1$) plane, a universal transformation of the special relativity is:

$$x_1' = x_1 ch\varphi - x_0 sh\varphi . \qquad (3)$$

$$x_0' = x_0 ch\varphi - x_1 sh\varphi . \qquad (4)$$

For the timelike interval, when we add an independent hypothesis: At the same space position (for example, the origin of K' frame, or for rest point, etc.), namely the premise x'=0 always exists. From Eq,(3) $th\varphi = x_1 / x_0 = v / c$ is obtained, and then we derive the well-known Lorentz transformation (LT):

$$x_1' = \gamma(x_1 - vt), \quad t' = \gamma(t - vx_1 / c^2), \qquad (5)$$

where $\gamma = 1/\sqrt{1-(v/c)^2}$.

For the spacelike interval $s^2 = r_{mn}^2 - c^2 t_{mn}^2 > 0$, the speed defined as $|v| = |r_{mn} / t_{mn}| > c$. We choose an inertial frame that $t'_{mn} = 0$ (the simultaneity), but $r'_{mn} = 0$ cannot be obtained. From (4) $th\varphi = x_0 / x_1 = c / \bar{v}$ is obtained, then we derive necessarily:

$$x_1' = \bar{\gamma}(x_1 - c^2 t / \bar{v}), t' = \bar{\gamma}(t - x_1 / \bar{v}), \qquad (6)$$

where $\bar{\gamma} = 1/\sqrt{1-(c/\bar{v})^2}$. This is called the generalized Lorentz transformation (GLT) [21,22]. LT and GLT are connected by the de Broglie relation $v\bar{v} = c^2$.

Therefore, in special relativity we provided that there are necessarily two symmetrical topological structures separated by the light-cone [21,22]:

A. The time-like interval $s^2 = r_{mn}^2 - c^2 t_{mn}^2 < 0$, and LT (5), in which group velocity v<c.
B. The space-like interval $s^2 = r_{mn}^2 - c^2 t_{mn}^2 > 0$, and GLT (6), in which phase velocity $\bar{v}$ >c is superluminal.

In deriving LT, an additional independent hypothesis has been used, thus the values of velocity are restricted absolutely, and the spacelike interval is excluded. Further, the fundamental

properties of any four-vector and the strange characteristic of these tachyons are described. The various superluminal transformations are discussed. Further, we think that LT is unsuitable for photon and neutrino, the photon transformation (PT) is unified for space $x'=r+ct$ and time $t'=t+(r/c)$. It may reasonably overcome some existing difficulties, and cannot restrict that the rest mass of photon and neutrino must be zero. LT, GLT and PT together form a complete structure of the Lorentz group. Based on the special relativity principle, an invariant speed c_h is necessarily obtained. Therefore, the exact basic principles of the special relativity should be redefined as: I. The special relativity principle, which derives necessarily an invariant speed c_h. II. Suppose that the invariant speed c_h in the theory is the speed of light in the vacuum *c*. If the second principle does not hold, for example, the superluminal motions exist, the theory will be still the extensive special relativity, in which the formulations are the same, only c is replaced by the invariant speed $c \rightarrow c_h$. If the invariant speed c_h are various invariant velocities, the diversity of space-time will correspond to many worlds [21,22].

At present, loophole-free Bell inequality violation using electron spins is separated by 1.3 km [23]. Energy-time entangled photon pairs violate Bell inequalities by photons more than 10.9 km [24] and 12.4 km [6]. Further, quantum teleportation is over 100 km, 143 km and 1200 km [25-27]. Some physicists proposed that their entangled distance is infinite, and even is an action at a distance. I think, the quantum entangled state is probably a new fifth interaction [22]. Its strength seems to obey neither the Newtonian long-range gravitational law nor the short-range strong-weak interactions.

Some physicists (Bell, Eberhard, Bohm and Hiley) suggested that quantum correlations could be due to superluminal communications (tachyons) that propagate isotropically with velocity v>c. For finite values of v, quantum mechanics and superluminal models lead to different predictions. Some years ago a Geneva group and Cocciaro group did experiments on entangled photons to evidence possible discrepancies between experimental results and quantum predictions. Cocciaro, et al., searched superluminal quantum communications on recent experiments and possible improvements. But, no evidence for these superluminal communications has been obtained [28]. Entanglement experiments have confirmed the superluminal action [10-12,28], therefore, this must apply GLT. Conversely, it can test GLT.

There is not randomness between entanglement, but rather general quantum correlations. Further, scientists have long discovered quantum correlations, with two or more particles in a particular system always showing the same state even far apart. When one of the quantum states changes, the other quantum changes accordingly. Such this scheme may extend to that <A| and |B> are quantum correlations, or general correlations.

So far, nonlocality is generally called spooky action at a distance. Such it is believed that the entangled states do not transmit information, but affect each other

instantly. We supposed that it is similar to electromagnetic field, which is a type of Laplace field (demon). It may apply to the superluminal communication. In a word, entanglement seems to be a particular synchronism.

Based on GLT (6) with superluminal in the complete special relativity, we proposed that the entangled states must obey GLT because of they possess the superluminal and some characters as the spacelike vectors. Further, it changes the phase of the entangled field, whose phase particle (phason) has some characters and corresponding equations. It is tachyon, and assume that it is similar to photon and J=1 and m=0 or mass is very small as similar neutrino, and may show the action at a distance. We researched that this field as wave has some characters, and discussed the superluminal quantum communication by a pair of entangled states is generated on both positions, or by preparing and transmitting a pair of entangled instruments, so the superluminal quantum communication. Manipulation for one position can pass the same message or information to the other, so we may implement the superluminal communication [29]. Assume that the entangled field has a similar magnetic theory, which may be a quantum cosmic field, or be the extensive quantum theory [30-32]. This may be probably the mysterious natural field on the induction between men and nature, God or the Buddha-fields [33,34] which correspond to real world is computer simulation or computational universe [35,36], three dimensional truth-goodness-beauty space [37] or body-mind-spirit space [38,39] and so on. These are all macroscopic fields, which correspond to de Broglie-Bohm nonlinear "hidden variable" theory [40,41], but it is microscopic [29].

Moreover, the exact quantum communication seems to be inconsistent with the quantum non-cloning theorem [42]. Further, Barnum, et al., proposed the quantum non-broadcasting theorem [43]. It should be related to the duality quantum computer [44,45].

5. Conclusion

Combining quantum entanglement and the generalized Lorentz transformation (GLT) for the spacelike interval in special relativity, we may establish two mutually entangled particles or devices, and derive the simple superluminal entangled communication scheme.

Einstein pointed out: "Logic will get you from A to B, imagination will take you everywhere". We believe study and application of nonlocality and entangled field have important scientific and social significance [29].

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