A Superluminal communication solution based on Four-photon entanglement

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Abstract :

Based on the improved design of Four-photon entanglement device and the definition of Encoding rules, Decoding rules and Error correction rules, we could be able to achieve the information transmission in the quantum channel directly, and lead to the superluminal communication result.

1. Introdution

At present, the quantum entanglement violated Bell's theorem [1,2,3,4] has been proved by many experiments. Some researcher tried to use the nonlocal property of quantum entanglement to process the Superluminal Communication [5], but ended in failure.

In resent years, multi-particle entanglement experiments [6,7,8] has also made a great progress. Based on Four-photon entanglement [9], we propose a solution to achieve the superluminal communication.
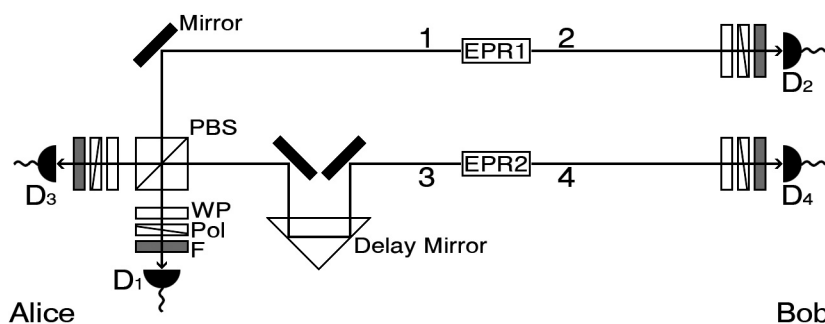
2. Solution

Fig.1: Experimental setup: The Four-photon entanglement experimental setup. It is composed by EPR sources, PBS, wave-plates (WP), Polarizers (Pol), Filters (F), Delay Mirror, Mirror and Detectors, and made into the Four-photon GHZ [10] entangled state.
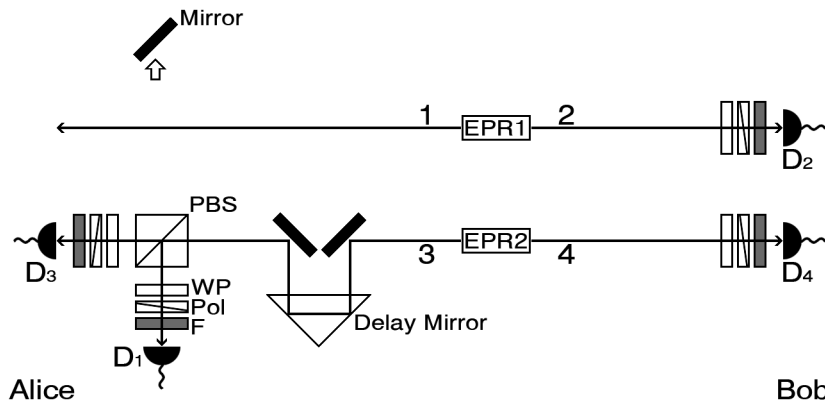
Fig.2: After moving out the mirror, The Four-photon GHZ entangled state has been broken. The 1st and 2nd photons have lost relevance with the 3rd and 4th. The Four-photon GHZ entangled has been broken down into two independent Two-photon entangled states.
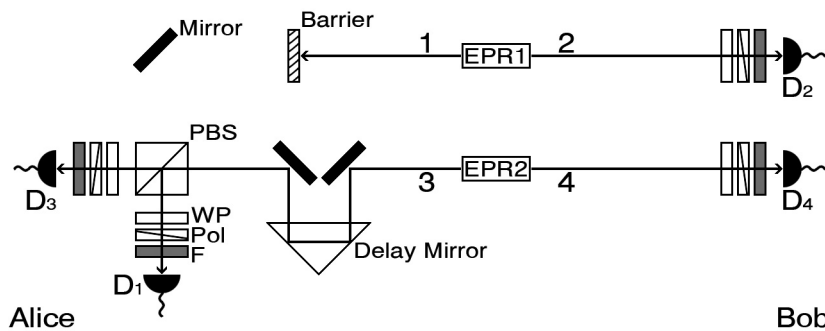

Fig.3: Place a barrier to block the photons through this light path between EPR1 and PBS, The Four-photon GHZ entangled state has been broken. The 1st and 2nd photons have lost relevance with the 3rd and 4th. The Four-photon GHZ entangled has been broken down into two independent Two-photon entangled states.

3. Discussion

For example, in Fig.1, we needs two EPR sources [11]. These two EPR sources send the entanglement photons at the same time intervals, and are made into the Four-photon GHZ entangled state:

$|\Psi\rangle = 1/\sqrt{2} \; (|H\rangle_1 \, |H\rangle_2 \, |H\rangle_3 \, |H\rangle_4 + |V\rangle_1 \, |V\rangle_2 \, |V\rangle_3 \, |V\rangle_4) \, .$

This state is kept stable. In this situation, Detector D2 and Detector D4 receive the photon polarization at the same time. There will be two combinations possible for this photon polarization:

(D2 = H, D4 = H) or (D2 = V, D4 = V) .

For example, in Fig.2, after we moved out the mirror, the Four-photon GHZ entangled has been broken down into two independent Two-photon entangled states:

$|\Psi\rangle = 1/\sqrt{2} \; (|H\rangle_1 \, |H\rangle_2 + |V\rangle_1 \, |V\rangle_2) \, ,$

$|\Psi\rangle = 1/\sqrt{2} \; (|H\rangle_3 \, |H\rangle_4 + |V\rangle_3 \, |V\rangle_4) \, .$

However, it is not important that which two entangled states will be broken down to. The key point is the Four-photon GHZ entangled state has been broken down.

In this situation, Detector D2 and Detector D4 are two independent systems. The photon received by Detector D2 has no relevance with the one received by Detector D4.

Detector D2 and Detector D4 receive the photon polarization at the same time. There will be four combinations possible for this photon polarization randomly:

(D2 = H, D4 = H) , (D2 = H, D4 = V) , (D2 = V, D4 = H) or (D2 = V, D4 = V) .

At first, we define a binary encoding rule for information sender Alice:

If Alice sent 1, it keeps the Four-photon GHZ entangled state. If Alice sent 0, it moves out the mirror, breaks down the Four-photon GHZ entangled state.

It is important to note that moving out the mirror is not the only way to break down the Four-photon GHZ entangled state. For example, we can move out the PBS or the Delay Mirror, place a barrier to block the photons through this light path between EPR1 and PBS (as shown in Fig. 3), or between EPR2 and PBS.

Secondly, we define a binary encoding rule for information receiver Bob:

(D2 = H, D4 = H) = 1 ,

(D2 = V, D4 = V) = 1 ,

(D2 = H, D4 = V) = 0 ,

(D2 = V, D4 = H) = 0 .

If Alice sent 1 to Bob, it keeps the Four-photon GHZ entangled state.

Bob received the information. The information result has two possibilities: (D2 = *H*, D4 = *H*) or (D2 = *V*, D4 = *V*) . The same value 1 will be got from them after decoding.

If Alice sent 0 to Bob, it breaks down the Four-photon GHZ entangled state.

Bob received the information. The information result has four possibilities: (D2 = *H*, D4 = *H*) , (D2 = *V*, D4 = *V*) , (D2 = *H*, D4 = *V*) or (D2 = *V*, D4 = *H*) .

The values got from them after decoding is 1,1,0,0. Apparently, these two values 1 are not the expected results. It leads to 50% Bit Error Rate.

To reduce the Bit Error Rate, We do the continuous testing for N times. And there is a definition of Error correction rules:

If the results appeared N times value 1 after N times testing, it is considered as 1. If the results appeared one or more than one times value 0 after N times testing, it is considered as 0.

Take 3 times testing as example, the Error correction rules is as below :

(1, 1, 1) = 1 ,

(1, 1, 0) = 0 ,

(1, 0, 1) = 0 ,

(1, 0, 0) = 0 ,

(0, 1, 1) = 0 ,

(0, 1, 0) = 0 ,

(0, 0, 1) = 0 ,

(0, 0, 0) = 0 .

Under this rule, the Bit Error Rate $P = 1/2^N$. It is known that after the more and more times testing, the Bit Error Rate is getting lower and lower.

For example, after 10 times testing, the Bit Error Rate is 1/1024. After 20 times testing, it is 1/1048576.

After above analysis, the solutions could be summarized as this:

1) Through the transitions between Four-photon entanglement and Two-photon entangled state, we do the encoding operation.

2) We do the decoding operation on the detection results of detector D2 and D4 , and

combine with the Error correction rules to reduce Bit Error Rate .

4. Conclusion

Based on the improved design of Four-photon entanglement device and the definition of Encoding rules, Decoding rules and Error correction rules, we get this conclusion: It would be able to achieve the information transmission in the quantum channel directly, and lead to the superluminal communication result.

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