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The Primary Exploration of Application of Quantum Entanglement Weak Measurement in Superluminal Communication

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Abstract: The entanglement properties of the quantum channel in quantum communication did not play well, in order to realize quantum communication at superluminal speed with the help of this entanglement property, a kind of quantum communication mode which can measure the change of quantum information is proposed in this article. This method can bypass the classical channel part in the quantum communication. In the concrete realization process, by combining the quantum weak measurement method, information transmission can be carried out without destroying entangled states, so as to achieve superluminal communication.

1. Background and Significance

In recent years, with the development of the theory of quantum mechanics, quantum entanglement becomes more and more important resources in quantum information and quantum computation, has been widely used in quantum teleportation, quantum cryptography and quantum communication and other quantum information processing [1,2]. Quantum entanglement shows the existence of non-classical strong correlation and non-local effect between quantum systems, which can be able to distinguish between quantum theory and classical theory. For the entangled states are strongly correlated, no matter how far in space the two particles are there is a quantum correlation between each other. In the measurement of the system, the measurement of one of the particles will lead to the collapse of the quantum state of the other particle [3]. That is to determine the state of particles. However, for this kind of spooky action at a distance in quantum communication, it is very promising.

In the theory of quantum mechanics, the two states of the A and B (EPR pairs) of the half spin particles are recorded as |0> and |1>, respectively, they are in the quantum state as a system (called EPR States) [4]:

$$|\Psi\ (A, B)\rangle = \frac{1}{\sqrt{2}}(|0\rangle A|1\rangle A - |1\rangle A|0\rangle B) \quad (1)$$

The $|0\rangle_A$ represents the intrinsic state of the A spin of the particle, and the other analogies. In fact, this is a quantum entangled state. System of quantum states represented by (1), before being detected, the spin state of each particle is uncertain,

Can only predict the probability of the particle A (or B) measured spin up (or down) is 1/2. Once a person has measured the spin state (up or down) of one of the particles (A or B), the spin state of another particle (B or A) is immediately determined (downward or upward). No matter how far away the two particles are, they are in a state of mutual association. This is the non-local effect of quantum mechanics. For the non-local effect is revealed by the principle of quantum mechanics in EPR experiments, so people call it EPR effect.

Nowadays according to the literature [1], the technique used in quantum communication is quantum teleportation. However, quantum teleportation requires a classical channel, which restricts the inherent advantages of quantum entanglement in communication. If we can overcome the limitations of classical communication, then it will bring about a great improvement in quantum communication.

2. The Idea of Quantum Communication Using Weak Measurement

In the quantum teleportation, all the quantum information of the unknown particles is needed to be transmitted, at this time can only be transmitted through the extraction of quantum information and classical information. This is very useful for quantum secure communication, but cannot solve the ultra-long distance communication. Delay and interference of classical channel, as well as the traditional network load pressure for the communication which seek safety and accuracy of large capacity is undoubtedly a short board. Therefore, how to bypass the classical channel to transmit information is the main problem in this paper.

For the collapse effect of quantum state, either measurement or observation can cause the collapse of the quantum state, making it lose the properties of quantum states, producing back coherence. In order to avoid collapse, we can use the method of weak measurement. Quantum weak measurement is essentially a kind of partial collapse measurement based on the von Neumann measurement and positive semidefinite operator value measurement. Before the two qubit quantum state encounters the decoherence environment, front quantum weak measurement should be implemented, and after this environment corresponding inversion measurement should also be implemented. Then the entanglement of quantum states can be effectively protected[5]. From the point of view of mechanism, combined with the previous quantum weak measurement and the corresponding inversion measurement there are two main reasons for the suppression of decoherence: First, the implementation of the pre quantum weak measurement is to reduce the weight of the number of system excitation, in order to reduce the impact of noise in the environment. Second, the implementation of the post feedback measurement is to make the recovery of the weight of the number of excitation after the interaction between the quantum state and the noise environment, which can make the destroyed initial state get recovery probably. In the scheme of quantum weak measurement, the case of the wave packet collapse will not occur when the measurement is carried out, and the coherent superposition of the quantum system can be kept, but the cost is that a measure of the amount of information obtained on the system is very small [6,7]. Then the small signal can be amplified until the amount of change in the quantum system can be detected, so that information can be measured.

The weak measurements mentioned above have been implemented in the laboratory. The research team led by R. Vijay have finished the experiment report named Quantum Feedback Control of a Superconducting Qubit: Persistent Rabi Oscillations [8], which is a frequency based measurement. The feedback control loop is designed to generate feedback to correct the effects of system observations, in order to measure and record the quantum states which can be used for continuous tracking and feedback. The quantum measurement can be carried out without destroying the quantum state by using the superconducting circuit. And it has been proved that a continuous analog feedback scheme can oscillate stably in the superconducting quantum bit loop and keep them independent and persistent.

In this way, a quantum communication mode based on quantum changing information is proposed. That is, we can transfer the only part of the quantum state instead of the complete quantum state, and then measure the change of the previous transmission and the second transmission. For example, if the status of the first transmission is |0>, and the state of the second transmission is |1>, can be judged as a change, recorded as 1; If the second time is still |0>, note 0. Because of the entanglement of quantum states, at the transmitter, a front quantum weak measurement will change the state of the quantum system.

The specific communication process can be divided into a communication part and a measurement part, they are intertwined with each other. We can define the time slot T, the initial state is set to unknown quantity x. At the receiving end, a weak measurement should be carried out firstly, and the state of the x' is recorded at the time. A front quantum weak measurement is carried out at the sending end after T time. The only front quantum weak measurement is to change the transmission at the sending end so the quantum state changes at the sending state. Then we implement complete weak measurement once at the receiving end, recording the status as x1'. If the transmitter does not carry out the post feedback measurement in the T slot, then x' must be different from x1', so this T time slot sends "1"; If in the T time slot we implement post feedback measurement at the sending end, the quantum state does not change, that is, x 'and x_1' are same, this T time slot sends "0", as shown in figure 1. Sending a code requires two slots, so time slots should not be interrupted. Because the code word is only related to this time slot and the upper slot, this system has strong anti-interference ability. The size of the slot can determine the transmission rate of the system. And the time slot should be set to the same value in the same transmission system. So that communication can be achieved. If there is no post feedback measurement loop, the entanglement relationship will eventually be destroyed, so it needs to be improved in 0 and 1 of the coding settings, so as to prolong the effective time.

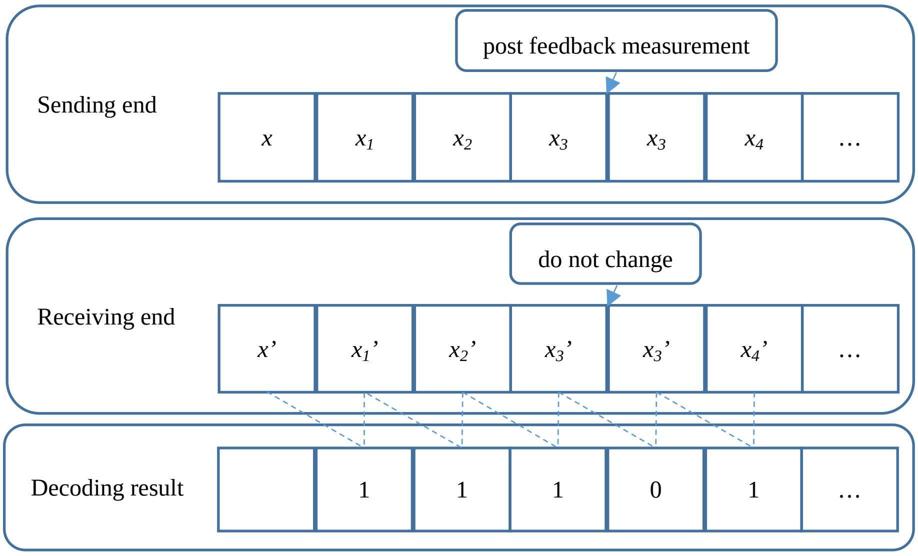

Figure 1: Transmission time slot.

3. Conclusion

If the quantum communication method proposed in this paper is effective, the superluminal transmission of information will become a reality, and it will be of great importance to the information technology industry and space exploration. But at present, the method mentioned in this paper is difficult to implement and the cost is high, and it is necessary to improve the theory and experiment. In future research, this theory should be perfected combining Weak Measurement with measuring the change of quantum information, which can find a more practical way of quantum communication.

References

[1] Bennett, C.H., Brassard, G., Crepeau, C., Jozsa, R., Peres, A. and Wootters, W.K. (1999) Teleporting an Unknown Quantum State via Dual Classical and Einstein-Podolsky-Rosen Channels. Quantum Entanglement and Quantum Information--Proceedings of CCAST (World Laboratory) Workshop. 70: 1895

[2] Nielsen, M.A. (2000) Quantum Computation and Quantum Information. Cambridge University Press, Cambridge, England.

[3] Ge, H. (2014) Research on Quantum Secure Direct Communication and Network Technology. Hubei: Huazhong University of Science and Technology.

[4] Su, X.Q. and Guo, G.C. (2004) Quantum Teleportation. Progress in Physics, 24(3).

[5] He, J. (2015) Study on Quantum Weak Measurement and Quantum Correlation. Anhui University.

[6] Turek, Y. (2012) Quantum Weak Measurement Theory and Its Applications. Beijing: Chinese Academy of Sciences.

[7] Aharonov, Y., Albert, D.Z., and Vaidman, L. (1988) How the Result of a Measurement of a Component of the Spin of a Spin-1/2 Particle Can Turn Out to be 100. Physical Review Letters, 60(14):1351-1354.

[8] Vijay, R., Macklin, C., Slichter, D.H., Weber, S.J., Murch, K.W. and Nail, R. (2012) Quantum feedback control of a superconducting qubit: Persistent Rabi oscillations. Physics.