Quantum Entanglement and Its Application in Quantum Communication

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Abstract: Since the concept of quantum entanglement was proposed, quantum entanglement has been paid more and more attention. Especially in recent years, with the interdisciplinary and interdisciplinary development of quantum informatics, the general definition, physical properties and entanglement measurement of quantum entanglement have been comprehensively and deeply studied. Due to its nonlocality, quantum entanglement has been widely used in quantum information, especially in quantum communication. In view of the application status of quantum entanglement in quantum communication, this paper presents a survey of quantum entanglement and its application in quantum communication. In this paper, 230 staff members from 15 Chinese companies involved in quantum communication are selected as the investigation samples, and the proportion of quantum entanglement in the application is obtained, which can promote the quantum communication. The capacity, speed and security of quantum entanglement and ordinary quantum in the application of quantum communication are compared. Through the analysis, it is concluded that each index of quantum entanglement is conducive to the development of quantum communication. Quantum entanglement provides a technical guarantee for the research of quantum communication.

1. Introduction
In the field of quantum mechanics, when multiple interacting particles interact, the overall properties of each interacting particle are systematically synthesized to form a system integrated property, which cannot be used to describe the overall properties of each interacting particle, but the system can only describe the overall properties of the whole system. This kind of entanglement is called three-dimensional quantum space entanglement [1-3]. For example, for two unrelated energy particles, when one associated particle is measured together, a corresponding energy change of the other associated particle may occur at any remote physical location. There may not be any information transmission between them, but there may be some cross domain spatial interactions [4-5].

In recent decades, the interdisciplinary and interdisciplinary comprehensive theory of quantum force and informatics and the research work of key laboratories have made considerable and steady progress [6-7]. Entangled state theory plays an important role in the transmission of quantum mechanical information. This paper is mainly used to study the application of quantum wireless entanglement and its important application in modern quantum wireless communication technology [8-10]. The study of quantum entangled state and its practical application in the international quantum physics information science research not only has important international academic research significance for us to deeply study and understand the physical characteristics of quantum mechanics, but also has practical value for the research and development of new quantum information processing technology and methods.

In this paper, according to the actual situation of quantum communication in China, the analysis shows that there are still some deficiencies in the application of quantum entanglement in quantum communication. In this paper, a survey of quantum entanglement and its application in quantum communication.
communication is presented. In the research, according to the characteristics of China's quantum communication, combined with the characteristics of quantum entanglement, the development strategy is proposed, which has a positive impact on quantum communication, and effectively improves the competitiveness of quantum communication. Through the investigation and analysis of the influence factors of quantum entanglement among different groups, this paper believes that the application of quantum entanglement in quantum communication can promote the rapid development of quantum communication, and thus enhance the comprehensive strength of quantum communication.

2. Definition of Quantum Entanglement and Quantum Communication

2.1 Definition of Quantum Entanglement
Theory of quantum space entanglement describes that the quantum and particle systems of each point are interrelated and inseparable. If the quantum state of the composite system cannot be directly expressed as the direct product of the quantum states of the two composite subsystems, then the pure state of the system may be a pure quantum state or an entangled state. It is extended to the case of mixed states, that is, the mixed state of the whole system is not completely determined, but is in a corresponding quantum state in a certain probability form. We describe the mixed state by the quantum density matrix. When the mixed state cannot be accurately expressed as the various forms of direct integrable state, and none of them can be nonlinear entangled, the mixed state is a non-entangled state. When a composite subsystem cannot have three or more subsystems, and two subsystems cannot be combined in the form of composite direct product function of each subsystem, the pure state or mixed state of the composite state is its entangled state.

2.2 Quantum Communication
In the classical network information communication theory and network communication science, "bit" is usually the most basic definition concept and basic measurement unit to define the amount of information. Quantum bit unit is the unit of measurement for transmitting quantum scientific information. Both quantum symbolic information theory and mathematical quantum information communication theory are based on mathematical qubit. They and some of them studied the traditional quantum information communication technology field earlier, and combined the traditional quantum communication theory with scientific information theory. At first, when a concept of quantum wireless communication was first widely proposed, everyone did not fully agree. It was not until a few years later that people really began to understand the basic concepts of quantum wireless communication. Quantum teleportation, quantum dense communication coding and quantum spatial secret information sharing are the main applications of quantum teleportation.

3. Investigation and Analysis of the Application of Quantum Entanglement in Quantum Communication
Research shows that more than 92% of quantum communications at home and abroad take quantum entanglement as the core factor of industry competitiveness. The application of quantum entanglement in quantum communication has been increasing in recent years. In the application of quantum communication, quantum entanglement has the effect of fast transmission, unlimited capacity and absolute security, which enables users to have accuracy from multi-dimensional and multi-dimensional, so as to achieve the maximum analysis effect of quantum communication, and effectively improve the efficiency and quality of quantum communication.

In the research and analysis, this paper adopts two methods, namely questionnaire survey and sampling survey. A total of 230 staff from 15 Chinese companies involved in quantum communication were selected as the sample. In the process of investigation, we find that both the researchers of quantum communication theory and the operators of quantum communication technology all involve the application of quantum entanglement in the range of quantum communication. In this survey, we conducted a data survey on two groups of people. One group is the researcher of quantum
communication theory, the other group is the operator of quantum communication technology. The development of quantum entanglement in quantum communication is analyzed. The results are shown in Table 1. Based on the two sets of survey results, quantum entanglement in quantum communication applications, can promote the advanced and enhanced quantum communication competitiveness.

Table 1: investigation and analysis of the development of quantum entanglement in quantum communication

| Investigation items | Quantum communication theory researchers (%) | Operators of quantum communication technology (%) |
|--------------------|---------------------------------------------|-----------------------------------------------|
| Play a promoting role | 90                                          | 92                                           |
| without effect      | 3                                            | 2                                            |
| It doesn't work     | 7                                            | 6                                            |
| It is suggested to increase the input of quantum entanglement | 93                                          | 95                                           |

4. Discussion

4.1 Quantum Entanglement Operation

Entangled state information of quantum science is a kind of magical quantum physical information resource used in quantum science information processing. It has been playing an important role in modern quantum mechanics communication and other quantum mechanics calculations. Entanglement conversion operating system is used to realize the mutual conversion of various quantum mechanical entanglements between different space particle forms by means of quantum physics science. In the field of modern quantum entanglement information processing technology, the quantum entanglement signal operation realized by LOCC method mainly includes the measurement of quantum local bell benchmark, entanglement signal exchange and quantum entanglement signal purification. The following is a brief introduction to the functions of these file entanglement processing operations.

4.1.1 Local clock-based measurement

In quantum communication, local bell-based measurement measures two qubits on the same side of the communication and projects them to one of the four Bell States. This is obviously very important for quantum communication because it is a key step to realize quantum teleportation.

4.1.2 Entanglement swapping

In 1993, the scientific concept of entangled matter exchange in quantum mechanics was proposed for the first time. The measurement of the epbpll ground state of two neutral particles in a control particle center can cause them to collapse and form an EPR particle entangled state, and two distant neutral particles can also be entangled by them to form an EPR particle entangled state. Before and after the entanglement operation, the number of particles in EPR state does not change much, which is considered to be two. However, after entanglement, the state pairing parameters of particles have changed greatly, which is the English origin of the name "entanglement swapping".

Entangled state exchange system of quantum states is a kind of invisible genetic state based on quantum states in super atomic space system. It just transmits a form of quantum mechanical entanglement between two particles, which makes the distant unrelated particles entangle in a similar way. The main reason of entangled bit exchange is the realization of remote wireless quantum information communication with quantum information relay station, which will directly lead to a great
decline in the quality of quantum information wireless transmission data and the quality decoherence of entangled bits. In order to realize the teleportation and encryption of quantum communication, an entangled state must be redistributed in a remote place.

4.1.3 Purification of entanglement
In a quantum microwave communication transmission channel, due to a variety of unavoidable natural environment noises, the microwave quality coefficient of "quantum entangled state" will gradually decrease with the increase of microwave transmission channel distance, that is, with the gradual increase of microwave transmission distance, the mutual entanglement between two neutral particles will gradually degenerate. Therefore, the entanglement coefficient will gradually increase and the mass will decrease. It is necessary to adjust the high entangled state from the lowest entanglement "purification" to the lower highest entanglement.

No matter what kind of entanglement operation, decoherence is the biggest obstacle of entanglement operation. Entanglement purification is an effective method to overcome environmental noise and decoherence: it can keep the logarithm of single entanglement high purity.

Figure 1: comparative analysis of capacity, speed and security between quantum entanglement and ordinary quantum in quantum communication applications

Figure 1 shows the capacity, speed and security comparison of quantum entanglement and ordinary quantum in quantum communication applications. In order to further analyze the application of quantum entanglement in quantum communication, the results are shown in Figure 2. As can be seen from Figure 2, quantum entanglement plays an important role in the inspection, calculation and information processing of quantum communication. The introduction of quantum entanglement in quantum communication is conducive to avoid the imprecise and unscientific content in the planning, and the effect is also significantly improved. They believe that the advantages of quantum entanglement outweigh the disadvantages in the development of quantum communication applications, and that it is necessary to promote quantum entanglement.
4.2 Application of Quantum Entangled States in Quantum Communication

Due to the special quantum connection of entangled states, people gradually realize that entangled states are a useful source of information. The application of entangled states in quantum communication has attracted people's attention. Great progress has been made in the experiment and application of quantum sealed communication. The applications of entangled states include: quantum teleportation, quantum dense coding, quantum key distribution and so on.

4.2.1 Remote cloning using entangled states

Quantum entanglement plays an important role in quantum information. Since the famous EPR paradox was proposed, entanglement has become the core concept of quantum theory. Many quantum information schemes related to information transmission, processing and storage are designed to generate and manipulate the quantum entanglement between qubits within a certain distance. Quantum teleportation is an important example of quantum information processing. As far as teleportation is concerned, the establishment of the maximum entangled state of two distant qubits enables any unknown single bit quantum state to be teleported from one to the other with fidelity 1. Of course, the non-cloning theorem of quantum states States that these copies cannot be completely accurate. This makes it impossible for a multi-user quantum channel to obtain an exact copy of the input state at each receiver. For Alice, the best way is to send an approximate quantum clone. This requires a combination of teleportation and ideal quantum cloning. In fact, it can be seen as a natural extension of multiple receivers of quantum teleportation.

4.2.2 Quantum dense coding using entangled states

Since we proposed using EPR to realize quantum density, great progress has been made in theory and practice. Quantum dense coding extends from two-level entanglement to multi-level entanglement. Quantum dense coding transmits classical bits through quantum channel, that is, only one qubit can transmit, while two kinds of classical information can be transmitted through quantum entanglement. The method is that the sender and the receiver each have a maximum entangled particle and are in a maximum entangled state. Because the two particles are entangled, any operation on one particle will...
affect the other particle, resulting in the formation of phase. This is the so-called "dense coding", which is also the simplest dense coding.

5. Conclusions
In the process of studying the application and development of quantum entanglement in quantum communication, this paper takes the introduction of quantum entanglement into quantum communication as the main line of research. After research, this paper considers that quantum entanglement is an indispensable part of the development of quantum communication applications. Through the investigation and analysis of different groups of people involved in quantum communication, their investigation on the development of quantum entanglement in quantum communication is obtained analysis. It can be seen from the research that quantum entanglement has the advantages of wireless capacity, unlimited transmission speed and absolute security, and has been widely used in various fields of quantum communication. Through the investigation and analysis, it is concluded that the development of quantum entanglement is conducive to avoid the imprecise and unscientific content in the planning, and can increase the competitiveness of quantum communication. The results show that for quantum communication, to make full use of quantum entanglement, we must integrate quantum entanglement with the actual situation of quantum communication effectively. This paper analyzes the development process of quantum communication under quantum entanglement, attaches importance to the introduction of science, and formulates development strategies to ensure the effective development of quantum communication. This study has achieved ideal results and made contributions to the application of quantum entanglement in quantum communication.

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